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CIVIL ENGINEERING.

On the Resistance of the Vertical Plates of Tubular Bridges. By H. Haupt, Civ. Eng.

[Read at the Meeting of the American Association for the Advancement of Science, July, 1853.—Communicated by the Author.]

The great desideratum in the construction of bridges, is an arrangement of parts that with a given weight of material will possess the most efficient powers of resistance.

An arch fulfils the condition of maximum resistance with a given weight of material when the distribution of the load is constant. With a permanent weight, whether uniformly distributed or not, there is a curve of equilibrium, and a given amount or weight of material arranged to conform to this curve, will give the maximum of resistance which the material is capable of opposing.

But for ordinary bridges, especially for railroad purposes, there can be no curve of equilibrium; the load is not only variable, but very great in proportion to the weight of the structure, and were an equilibrium possible in one position, it could remain stable only for an instant, as the transit of the load to another position would at once disturb it.

It is evident, therefore, that the principle of equilibration is applicable only to aqueducts, or other structures upon which the loads are nearly constant, and that to render an arch capable of sustaining a variable load, it must either be made so deep that the variations of the curve of pres-

sure will never pass outside the arch, or it must be combined with a resisting truss capable of effectually opposing any tendency to change of figure.

Most of the bridges in general use are illustrations of this species of combination; but the main reliance is usually placed upon the truss, the arch being used merely as an auxiliary.

When wood is used, this increase of material is not objectionable, except so far as it increases unnecessarily the weight of the structure; but where iron is employed, it becomes essentially important that the distribution of the forces should be understood, the strains upon all parts of the structure accurately determined, and the dimensions correctly proportioned to the required resistances.

The principles involved in these calculations have already been given to the public, in a work on the *General Theory of Bridge Construction*, and no further reference to them is required, except to state that an application of these principles would lead to a radical change in the manner of constructing bridge trusses; and, instead of using an arch as an auxiliary to a truss, the arch would be made the chief dependence, and the truss employed to resist the action of variable loads, and prevent change of figure in the arch during their passage over the bridge. When disposed in this manner, a given quantity of material will oppose an efficient resistance either to vibration, flexure, or fracture.

In tubular iron bridges, which have recently attracted much attention, no difficulty is found in determining the strains upon the horizontal tables, and in proportioning them correctly; but the dimensions of the vertical ribs, and the best manner of stiffening them, will depend not only upon the magnitude of the weight, but upon its mode of application.

If the weight be supposed applied at the middle of a tubular bridge, its action would tend to shorten the diagonal extending from the middle of the top chord or table to the end of the bottom table, and at the same time to elongate the opposite diagonal from the middle of the bottom table to the end of the top table. As the strain upon the last diagonal would be tensile, its ability to resist would be nearly as the strength of the material; but the opposite diagonal, being subjected to compressive forces, would, if it formed a line of a thin plate of metal, be unable to oppose any efficient resistance, and the bridge would probably fail in the direction of this diagonal. It becomes necessary, therefore, to provide means for stiffening the ribs, and this is usually effected by riveting to them vertically pieces of T-iron at short intervals.

By these additions, the distribution of the strains is changed, and the action of the parts is similar to that of a truss on the Pratt plan—the vertical stiffeners taking the place of the posts, and the lines of sheet iron connecting the opposite angle of any panels having a corresponding action to the ordinary diagonal rods.

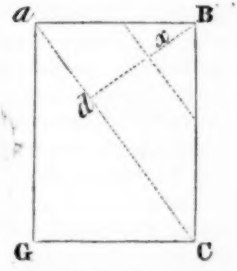
The resistance which such an arrangement is capable of opposing, it is proposed to determine from the following considerations:

In the general theory of bridge construction, it has been demonstrated that where the load is uniformly distributed, the vertical strain increases uniformly from the middle to the ends; the strain upon the diagonal of any panel will be as the length of the diagonal to the length of the verti-

cal side, and also as its distance from the middle of the truss; the maximum vertical strain being of course equal to the whole weight of the bridge and its load, with the momentum due to motion and vibration, when the structure is not rigid.

It has also been shown that the vertical and diagonal strains upon any panel, which are always proportioned to each other in a fixed ratio, are also in proportion to the degree of angular motion or change of figure in any panel caused by flexure, and as the settlement of a bridge to the figure of an inverted arc would not change the rectangular shape of the middle panel, the vertical and diagonal strains upon this panel would be theoretically nothing; while, at the end of the truss, the variation from a rectangle and the intensity of the vertical and diagonal strains would be greatest.

Knowing the whole weight of the structure, the strain upon any panel is readily determined, and it is now proposed to inquire what will be the resistance of a sheet of metal securely attached to all the sides of a rectangle, in comparison with an equal quantity of material arranged in the form of diagonal rods. It is evident that the consideration of this question will afford the means of comparing the relative efficiency of the distribution of the material in tubular bridges, as compared with diagonal panel rods.



Let *a c*, in the annexed figure, represent the diagonal which is subjected to a tensile strain, and R the resistance per unit of area which the material is capable of opposing; (*a*,) its perpendicular distance, B *d*, from the fulcrum B. The strain upon a unit at the distance *x*, will be in proportion to this distance, and will be represented by $\frac{R}{a}x$. But as the efficiency of the resistance will be in proportion to the leverage, which is *x*, the whole effect of a unit of material at the distance *x*, will be expressed by $\frac{R}{a}x^2$, and the sum of the resistances along the line *d* B, obtained by the usual method of integration, will be $\frac{1}{3}$ R a^2, or, $\frac{1}{3}$ R $a + a$. As R represents the resistance of the material per unit of area, and (*a*) the number of units in the distance B D, R *a* would represent the resistance of a rod whose area is *a*, and R $a + a$ its moment of resistance at the distance B *d*.

As the resistance of the triangle, *a* G C, is necessarily equal to that of *a* B C, the whole resistance of the rectangle *a b c g*, will be $\frac{2}{3}$ R a^2. The resistance expressed by $\frac{2}{3}$ R a^2, is obtained by the use of an area of material represented by *a c* + B *d*. If this same amount of material should be placed in the form of a rod in the diagonal *a c*, its cross section must be equal to B D, or *a*, and its effective moment would be R a^2.

It appears, therefore, that the power of a plate to resist an angular change of figure in a rectangular frame, will be two-thirds as great as that of an equal quantity of material placed in the direction of the diagonal. Where a truss is designed to support a constant weight uniformly distributed, or in other words, where counter-bracing is unnecessary, the adoption

of the tubular or plate arrangement involves an expenditure of 50 per cent. more material than would be required by diagonal rods; but where the load is variable, as is always the case in bridges, and where rods are consequently required in both diagonals, the relative economy of the two arrangements is more nearly equal, and may even be reversed. In a truss which is unsupported by an arch, a calculation of the quantities of material required in the two arrangements involves a consideration of the strains produced by the variable and constant loads in each panel. In the middle panels, the strain from the weight of the structure being theoretically nothing, the diagonals resist only the effects of the variable load, and must be equal. If the area of each rod be represented by $\frac{2}{3}\ a$, the two would be $\frac{4}{3}\ a$; but as the braces and counter-braces are never both in action at the same time, the plate arrangement requiring a quantity of material represented by (a,) would be equivalent to the braces and counter-braces both, and would effect a saving of material equal to $\frac{1}{3}\ a$. *The rods in this case would require 33 per cent. more material than the plate.*

If $\frac{2}{3}\ b$ represent the material required in the rods of the end panels to resist the weight of the structure, then $\frac{2}{3}\ b + \frac{2}{3}\ a$, would be required for the main diagonal rods, and $\frac{2}{3}\ a$ for the counter-brace, making $\frac{2}{3}\ b + \frac{4}{3}\ a$. The plate arrangement would require $b + a$. The difference is, $\frac{b - a}{3}$. Hence, if a should be equal to b, the value of the expression becomes zero, or in other words, *if the variable and constant loads are equal at the end panels, the quantity of material in the rods and plates will be the same;* but if the variable load is least, there will be a loss of material by the use of the plates, which will be greater as the weight of the structure increases, and, consequently, *the relative economy of plates would be less for very long spans than for shorter ones.*

These considerations naturally lead to the substitution of sheet iron for the rods of wooden bridges, and its adoption will secure the essentially important advantages of simplicity, economy, incombustibility, and durability, if practical difficulties do not arise from the expansion and contraction of the plates when attached to wooden frames. As the expansion of diagonal rods is not found to be productive of any injury or inconvenience, it is possible that the slight bending or buckling which must result from the expansion of the iron plates, might not lead to any serious consequences; but whether the plan of constructing bridges by covering wooden frames with sheet iron be practicable or not, the result of the calculation that has been given proves that with a sufficient number of posts or stiffeners, the vertical plates in tubular iron bridges may be very thin, and still possess sufficient powers of resistance—a conclusion, the truth of which is confirmed by the experiments on the Britannia Bridge.

A tubular iron bridge without arches, to be properly proportioned, should have the number or thickness of the top and bottom plates increased, and of the side or vertical plates decreased gradually from the ends to the middle. A tubular bridge in which the plates are of the same dimensions in the middle and at the ends, must be very badly proportioned, and contain a large amount of useless material.

If v represent the variable load upon a single panel or interval between

two adjacent posts or stiffeners, n = number of panels, w the whole weight of the structure, then the proportion between the thickness of the vertical plates in the middle and at the ends, will be nearly as v, $\frac{n\,v + w}{2}$; as this proportion may readily be as great as 1 : 5, it follows that a very great saving may be effected by proportioning the thickness of the sheets in each panel to the strains, an arrangement that appears to have been overlooked or neglected in the construction of tubular bridges.

For the Journal of the Franklin Institute.

Experiments on Screw Propellers in H. B. M. Steamer Minx. By B. F. Isherwood, Chief Eng., U. S. N.

In 1847 and 1848, there were made by order of the British Admiralty, experiments on a number of screws applied to H. B. M. Steamer *Minx;* and I find in *Bourne's Treatise on the Screw Propeller*, a table of these experiments, for the first time published. This table appears to me, in the condition in which it is given, to be of but little value to the practical engineer, and liable, without careful discrimination, to mislead him. It is accompanied by no account of the manner in which the experiments were conducted, no classification is attempted, nor are there any deductions drawn. I have, therefore, selected from those experiments in which the results are consistent with each other and with the nature of things—rejecting anomalies—such of the observed elements as were not contradictory, and from them have made my own calculations and drawn my own conclusions.

The *Minx* was a vessel of the following dimensions, viz:

Length of hull between perpendiculars,	131 feet.
Beam, extreme,	22 " 1 inch.
Draft, mean,	5 " 2½ "
Immersed amidship section at 5 feet 2½ inches draft,	82 square feet.
Displacement at 5 feet 2½ inches draft in tons of 2240 lbs.,	203.

The machinery consisted of two vertical, oscillating, condensing engines, geared so as to give the screws four revolutions for each double stroke of engines' pistons.

Diameter of the cylinders,	34 inches.
Stroke of pistons,	2 feet 9 "
Space displacement of both pistons per stroke,	34·678 cubic feet.

The trials were made in the Thames river, at a measured geographical mile of 6082⅔ feet; the vessel being kept throughout at nearly the same draft of water.

The mean gross steam pressure in the engines' cylinders was ascertained by an indicator, and the dynamometer was applied to obtain the thrust of the screws. Now, the dynamometer measures simply the power applied to the propulsion of the vessel; that is, it measures that part of the total engine power which is expended in giving motion to the hull; and as it is evident that with the same vessel, under the same circumstances, greater speed can be obtained only by the application of greater

power to the hull, and greater in proportion to the cubes of the speeds, it follows that the dynamometer powers should be sensibly in the proportion of the cubes of the speeds within moderate limits: but the results, as given, show not only no fixed relation of the dynamometer power to the speed, but frequently a much less speed, accompanied by a much greater power; the dynamometer results must, therefore, be entirely rejected as erroneous.

The given number of revolutions made by the screw per minute, can doubtless be depended on as exact; and the steam pressure in the cylinders, as given by the indicator, can probably be depended on, not as strictly accurate, but as a pretty close approximation to the truth, as I find by testing, that in general the revolutions of the same screw in equal times, are nearly in the ratio of the square roots of the piston pressures, which should be the case.

The element most liable to error, and of the greatest importance, because its third power enters in the comparisons, is the speed of the vessel; an element obviously the most difficult to determine with exactness.

As the speed of the vessel for the purpose of comparison must be the speed in smooth water, uninfluenced by wind, current, steering, or unequal fouling of the bottom, and as these causes vary on every trial, and as it is impossible to ascertain their effects accurately, there must always be *some* error in the element of speed—an error which can only be reduced to an insensible amount by taking the mean of a large number of trials; the greater the number the less will be the error. In the experiments with the *Minx*, the number of trials made with each screw appears to have been too few, and it would have been more satisfactory had the final results been the mean of a greater number of observations.

The distance run of one geographical mile was too short, as the slight error of only a few seconds in the times of passing the stakes at each end of the course, if made in the same direction, would wholly vitiate the result; for instance, the true speed of the vessel being supposed 8 miles per hour, there would be required $7\frac{1}{2}$ minutes to run one mile; now, if an error of only 5 seconds be made in the time at each stake, being called that much too late at commencing, and that much too soon at stopping, making an error of 10 seconds in all, then the mile, instead of being run in $7\frac{1}{2}$ minutes, would appear to be run in $7\frac{1}{3}$ minutes, and the vessel's speed, which was really 8 miles per hour, would be given as 8·37 miles per hour; and as the cubes of the speeds are the measures of the effects, this discrepancy would become enormously exaggerated in the final result.

No drawings or descriptions being given of the screws tried, it is impossible to know their exact configuration; they were probably of uniform length from the hub nearly to the periphery, and the helicoidal area was made equal, or nearly so, in the several screws, by "*cutting off the corners*," as it is termed in *Bourne's Table of the Experiments*. It is not stated whether the areas of the screws, as given in this table, are the projected areas on a plane at right angles to the axis, or the helicoidal areas; they cannot, however, be the former, as they are too large, even on the supposition that the length was uniform from hub to periphery. The screws experimented with were all two-bladed, and of the same dia-

meter, viz: 4 feet 6 inches. They consisted of four series: 1st, Screws of uniform pitch. 2d, Screws of expanding pitch fore and aft, but of uniform pitch radially. 3d, Screws of expanding pitch radially, but of uniform pitch fore and aft. 4th, Screws of expanding pitch both fore and aft and radially. Each series will be considered separately.

Screws of Uniform Pitch.—The screws of uniform pitch were three in number, and had pitches of 5 feet 10 inches, 5 feet 6 inches, and 5 feet, which screws I shall call respectively A, B, and C. The screw, A, was modified by successively reducing its length by a plane at right angles to the axis, and experiments were made to ascertain the effect of each reduction.

With screw, A, (before modification,) six trials were made. Of these, the first two, made on the 4th and 5th June, 1847, I reject, as the results are too greatly inconsistent with the general results of the experiments, and too widely differing from the results of the last four trials, which closely agree with each other and with the general results; I therefore accept them. The mean of these four trials gives a slip of 37·3 per cent., from which the extremes do not differ 1 per cent.

The first modification of screw, A, was made by reducing its length from 1 foot to 10 inches, and its helicoidal surface from 7·1 square feet to 5·97 square feet. The mean of three trials with this modification gave a slip of 39·6 per cent., from which the extremes differ by only $\frac{2}{10}$ths of 1 per cent. This reduction in the length of the screw caused an increase in the slip of 2·3 per centum absolutely, or $\left(\frac{39{\cdot}6 - 37{\cdot}3 \times 100}{37{\cdot}3} =\right)$ 6·2 per centum relatively; or, in general, decreasing the surface one-sixth increased the slip one-sixteenth.

The second modification of screw, A, was made in the same direction and in the same manner as the first one, by cutting off 2 inches more, which reduced the length of the screw from 1 foot to 8 inches, and the helicoidal surface from 7·1 square feet to 4·93 square feet. With this modification, two trials were made, of which I reject the first, made 9th July, 1847, as the result is obviously erroneous; I accept the last trial, which gives a slip of 41·7 per centum. This reduction in the length of the screw caused an increased slip over that of screw, A, of $(41{\cdot}7 - 37{\cdot}3 =)$ 4·4 per centum absolutely, or $\left(\frac{41{\cdot}7 - 37{\cdot}3 \times 100}{37{\cdot}3} =\right)$ 11·8 per centum relatively; or, in general, decreasing the surface one-third increased the slip two-seventeenths.

A further experiment was made August 17th, 1847, in the same direction and manner, by reducing the length of the screw to 6 inches. Only one trial was made, and the result is so manifestly erroneous that I reject it.

With screw, B, two trials were made, of which I reject the last, made July 1st, 1848, as its result is greatly inconsistent with the general results. I accept the first trial, which gave a slip of 34·8 per centum.

With screw, C, three trials were made; the mean result gave a slip of 31·6 per centum, from which the extremes do not differ 1 per centum.

The following table exhibits in detail the data and results of the Screws of Uniform Pitch:

Designation of Screw.	Date of Trial.	Vessel's draft of water in ft. and in. Forward.	Aft.	Mean.	SCREW. Diam. in feet and inches.	Pitch in feet and inches.	Number of blades.	Length in direction of axis, in inches.	Helicoidal area in square feet.	Number of revolutions made per minute.	Slip of the screw in per centums of its speed.	ENGINES. Gross average pres. in the cylinders in lbs. per sq. in.	No. of double strks. of engines' pistons made per minute.	Horse power developed by the engines.	Speed of the vessel per hour in knots of 6082 feet.
A.	Sept. 4th, 1847.	4 6½	5 10½	....	4 0	5 10	2	12	7·1	216·7	36·8	10·12	54·18	....	7·882
	" 17, "	4 6½	5 10½	....	4 0	5 10	2	12	7·1	218·7	37·7	10·17	54·68	....	7·845
	June 30, 1848.	4 5	6 1	....	4 0	5 10	2	12	7·1	231·3	36·5	11·89	57·83	....	8·445
	July 12, "	4 5	6 0	....	4 0	5 10	2	12	7·1	256·9	38·2	12·97	64·23	....	9·130
	Means,	4 5¾	5 11½	5 2½	4 0	5 10	2	12	7·1	230·9	37·3	11·3	57·73	197·42	8·325
1st Modification of A.	Sep. 16, 1847.	4 7	5 10½	....	4 0	5 10	2	10	5·97	215·8	39·4	8·85	53·30	....	7·951
	" 17, "	4 7	5 10½	....	4 0	5 10	2	10	5·97	232·0	39·7	10·12	58·00	....	8·943
	July 1st, 1848.	4 5	6 0	....	4 0	5 10	2	10	5·97	252·0	39·5	12·26	63·00	....	8·765
	Means,	4 6	5 11	5 2½	4 0	5 10	2	10	5·97	233·3	39·6	10·40	58·32	183·56	8·110
2d Mod. of A.	Sept. 17, 1847.	4 6½	5 10½	5 2½	4 0	5 10	2	8	4·03	237·8	41·7	9·91	59·45	178·30	7·972
B.	June 30, 1848.	4 5	6 0	5 2½	4 0	5 6	2	12	7·1	240·6	34·8	11·44	60·14	207·48	8·514
C.	Sept. 11, 1847.	4 6½	5 10½	....	4 0	5 0	2	12	7·2	244·8	32·2	9·95	62·44	....	8·354
	July 1, 1848.	4 5	6 0	....	4 0	5 0	2	12	7·2	262·0	31·6	12·00	65·49	....	8·844
	" 12, "	4 5	6 0	....	4 0	5 0	2	12	7·2	250·1	30·8	10·22	62·52	....	8·531
	Means,	4 5½	5 10½	5 2½	4 0	5 0	2	12	7·2	254·0	31·6	10·70	63·48	205·56	8·576

If, now, we compare the pitches of screws, A, B, and C, (which are similar screws in all respects save pitch, having equal diameters, helicoidal areas, length and number of blades,) with their slips respectively, we shall find that the slips are sensibly in the direct ratio of the pitches, as appears from the following:

	Pitches.	Slips.
Screw A,	5·833, or 1·167	37·3, or 1·180
Screw B,	5·500, or 1·100	34·8, or 1·101
Screw C,	5·000, or 1·000	31·6, or 1·000

That this should be the truth, is manifest from the consideration that the rotary velocity of similar screws with unequal pitches to advance equal distances in equal times, is in the direct ratio of the pitches; and as the moment of pressure is as the rotary velocity, it follows that the resistances of equal screw surfaces will be as their rotary velocities, *i. e.*, as their pitches inversely, the lesser pitch having the greater resistance.

There remains to determine the relative economical efficiencies of the screws of uniform pitch. For this purpose, the horse powers developed by the engines will be taken as the expressions for the powers, and the cubes of the vessel's speed for the measures of the effects. The effects being divided by the powers, the quotients will represent the relative economical efficiencies.

	Powers.	Speeds.	Effects.	Relative economical efficiencies.
Screw A.	197·42 or 1·0000—	8·325 or 1·0000 and	$1{\cdot}0000^3=1{\cdot}0000$ and	$\frac{1{\cdot}0000}{1{\cdot}0000}=1{\cdot}0000.$
		1st Modification.		
Screw A.	183·56 or 0·9298—	8·110 or 0·9741 and	$0{\cdot}9741^3=0{\cdot}9244$ and	$\frac{0{\cdot}9244}{0{\cdot}9298}=0{\cdot}9942.$
		2d Modification.		
Screw A.	178·30 or 0·9032—	7·972 or 0·9576 and	$0{\cdot}9576^3=0{\cdot}8781$ and	$\frac{0{\cdot}8781}{0{\cdot}9032}=0{\cdot}9722.$
Screw B.	207·48 or 1·0509—	8·514 or 1·0227 and	$1{\cdot}0227^3=1{\cdot}0700$ and	$\frac{1{\cdot}0700}{1{\cdot}0509}=1{\cdot}0182.$
Screw C.	205·56 or 1·0412—	8·576 or 1·0301 and	$1{\cdot}0301^3=1{\cdot}0930$ and	$\frac{1{\cdot}0930}{1{\cdot}0412}=1{\cdot}0498.$

From the above we perceive that with similar screws, omitting the modifications of screw A, there resulted an *increased* efficiency from each *decrease* of the pitch. This increased efficiency could only have arisen from the decreased slip of the screws with lesser pitches, and as the helicoidal areas of the screws were the same, the frictions of the screw surfaces on the water must have been nearly equal, but a little greater with the screws of lesser pitch, on account of their greater helical speed. Now, as slip is a measure of the loss of useful effect, that loss should be in the direct ratio of the slip, as will appear from the following considerations:

As pressure and resistance are equal and in opposite directions, a pressure equal to the resistance of the vessel is always experienced by the water on which the screw acts propulsively; but the amount of power expended is proportional to the resistances moved and the distances through which they are moved in the same time. Now, supposing the screw to slip or recede one-fourth of its pitch per revolution by the yielding of the water on which it acts; that is to say, that per revolution it moves the vessel through but three-fourths of the pitch, instead of through the whole pitch, as it would do were there no slip; and, as pressure and resistance are equal and in opposite directions, there is the same pressure exerted by the screw upon the receding water as there is exerted by it on the advancing vessel; but in the supposed case of slip, the water acted on or pressed by the screw is moved a distance that can be represented by 1 in the same time that the vesseel is moved a distance that can be represented by 3, the whole distance moved being represented by 4, equal to the pitch of the screw. Calling the pressure on the engine piston 1, the total power developed by the engine can be represented by $1\times4=4$, of which $1\times1=1$ represents the amount expended on the slip, or one-fourth of the total power for a slip of one-fourth; while $1\times3=3$ represents the amount of power expended in overcoming the resistances of the vessel, or three-fourths of the total power developed. It is thus plain that the loss of useful effect caused by slip, is as the slip. It must be distinctly understood that the loss of useful effect *caused* by a slip of 25 per cent. is 25 per cent. of the gross or total power developed by the engines, and not 25 per cent. of what remains of the total power, after

deducting those fractions of it required for working the engines alone, and overcoming the friction of the load; for it is evident that at each revolution, 25 per centum of the power required for working the engines alone, 25 per centum of the power required for overcoming the friction of the load, 25 per centum of the power required for overcoming the friction of the screw surface on the water, and 25 per centum of the power required for propelling the simple hull, making a total of 25 per centum of the whole power developed by the engine, is lost by slip; for, by consequence of the slip, each of these fractions or divisions of the total power has to be exerted 25 per centum longer to produce the same result; that is, to cause the vessel to go the length of the pitch instead of the length of three-fourths of the pitch, than would be required were there no slip; and although, to make a revolution in the same time with slip, requires less piston pressure than to make the same revolution without slip, yet the useful effect will also be proportionably less, as the vessel will be driven in the same time through a less distance by the amount of slip. To obtain the same useful effect, that is, to drive the vessel through equal distances in equal times, the engines in the case of slip must be worked at a proportionably higher speed, which again requires a proportionably higher piston pressure, so that to drive the vessel equal distances in equal times, with and without slip, the piston pressures will have to be the same, but the speed of the engine, and consequently the power exerted, must be greater in the direct proportion of the slip.

On the above reasoning, we should find the relative efficiency of the different screws with equal surfaces to be sensibly in the proportion of the slips. Applying this, the following appears to be the correspondence:

Screw c has 3·2 per centum less slip than screw B, and 3·1 per centum more efficiency.
" " " 5·7 " " " A, " 5·0 " "
" B " 2·5 " " " A, " 1·8 " "

In the case of the same screw with reduced surfaces, this law will be modified, from the fact that the reduced surface has decreased the amount of friction of the screw on the water; therefore, the relative efficiency of the same screw with decreased surfaces will be in a higher ratio than the ratio of the slips. Applying this, we have the following:

1st Modification.

Screw A has 2·3 per centum more slip than screw A, and 6·1 of 1 per cent. less efficiency.

2d Modification.

Screw A has 4·4 per centum more slip than screw A, and 2·9 per centum less efficiency.

1st Modification.

Screw A has 4·8 per centum more slip than screw B, and 2·4 per centum less efficiency.

2d Modification.

Screw A has 6·9 per centum more slip than screw B, and 4·7 per centum less efficiency.

1st Modification.

Screw A has 8·0 per centum more slip than screw c, and 5·6 per centum less efficiency.

2d Modification.

Screw A has 10·1 per centum more slip than screw c, and 8·0 per centum less efficiency.

To be Continued.

*Comparison between English and American Railway Management.**

At a time when a parliamentary committee is sitting on railway policy, it appears opportune to bring before shareholders whatever evidence is calculated to assist in arriving at correct conclusions. The position of railway administration in England at the present moment is this: it is assumed by railway directors to be perfect; its perfection is very much doubted by shareholders and the public. The former have an idea that every care is not taken for economy, the latter that every care is not taken for public safety. The directors claim implicit confidence in their management, on account of the purity of their motives; the shareholders think that every respect may be paid to motives, but that a salutary investigation may be made into the details of management. We have always upheld this principle, and acting upon it we shall take advantage of an important public document just issued in the United States, to institute a comparison between English and American management. The extravagance of one line may be defended or palliated by the greater extravagance of another line; but the experience of a remote system may be accepted as impartial evidence, and it may better guide us in arriving at results. Here a certain set of engineers have given the same general character to the railway system and management; the school of Stephenson has become the school of England, and there has been little disposition to authorize anything which did not bear the stamp of legitimacy, as authoritatively imposed by the arbiters of railway expenditure. In the United States it has been different; there has not been that blind following of the high and mighty in engineering, and as there has not been a body of open-mouthed and open-pursed shareholders to draw upon, unlimited economy, and it may be said necessity, has in many cases been allowed to have some voice. Hence we may expect to get some evidence, which, though not arising from identical circumstances, may throw light on the case, or even, as being of a negative character, may determine the course of the investigation.

The documents before us are included in the report of Mr. McAlpine, the State Engineer of New York, in pursuance of a recent law that passed in 1850, and although the operation of the system of returns is not yet complete, a large mass of valuable statistical information is brought together, and the deductions are very carefully drawn. When we state that the length of railways embraced in these returns is between 1800 and 2000 miles, it will be seen the extent is ample for comparison. The circumstances, too, of New York State admit of a better comparison than those of other parts of America. The country is not throughout so thickly peopled as England; but there is a metropolitan population in New York City of 600,000, and there are many populous towns. There are districts approaching Scotland and Wales in population, and there are large seats of manufacture, and in some places an enormous transit trade. Thus there is a great variety of character in the traffic conditions, in some cases approaching those of our wealthy and thriving districts, in others going as low as the poorest parts of the Highlands or Welsh

* From Herapath's Journal, Nos. 732 and 733.

mountains. Some might reject the comparison for these latter circumstances, but they are indeed those which claim most attention. In these islands a total population of 30,000,000 have 7000 miles of railway; in New York a population of 3,000,000 have 2000 miles of railway. This is a proposition not lightly to be set aside without investigation. In Ireland 6,000,000 of people have one-third of the length of railway possessed by half the population in New York, or one-sixth of the supply. The case of Scotland is generally better, the same population as New York having half the length of railway.

The passenger traffic on 1900 miles of railway in 1852 was 7,440,653, and the number of miles run, 343,358,545, which gave an average mileage per passenger of 46 miles. In 1851, the average distance travelled by each passenger was 47 miles; so that from discrepancies in the returns some of the figures must be received with caution; but this may be taken as a fair average. This rate is far above the European standard, as the average rate in England and Belgium is only about one-half of the above. The American returns include little of what is known as short or omnibus traffic; while from the great extent of the country and the widely scattered population, for which railways afford the most convenient transit, the distance of the journeys is greater than here. The returns likewise include a large proportion of through emigrant traffic to the far West. The average suggests some interesting reflections; first, that the American traffic is not to such a great proportion as ours intermediate; and, second, that a railway system can be carried out where the average mileage of each passenger is 46 miles, as must be the case in some thinly peopled colonies and countries requiring great length of railway. This illustration will be found useful in reference to the Canadian railways, the traffic of which is little understood here.

The average speed of the passenger trains is given as 26½ miles per hour, but this seems to be the speed without stoppages. At any rate, it is not a very high speed, but it is found suitable for a large proportion of the traffic. In this country, the question has been little considered how far low speeds and cheap fares can be made to work profitably, except so far as the Irish lines are concerned, though there the tendency is towards increasing the speed. In New York the emigrant traffic to Canada and the West is carried at very low rates, and it is contemplated to do the same on the Great Canadian trunk.

The average number of passengers in a train is returned at 77·6, the number of trains per day being generally much less than in this country. The great endeavor in the United States is to give the public low fares, and the Companies a low rate of expenditure, and every thing is directed upon these two principles, which are made to work together. By running few trains, at reasonable speeds, and by attending to the construction of the carriages, much economy is obtained. The American carriage being, as is well known, on a larger scale than here, and allowing of internal communication, admit of being worked cheaper with respect to the staff on the line and in the stations, and is effectively more convenient to the public than the English railway carriage. This is a subject well worthy of inquiry, as much of the economy of American railways depends upon it, but at present we can only briefly refer to it. The effect is to reduce

the expenses of fixed stations, and to allow of passengers being worked from places where, on the English system, a station could not be maintained. Instead of a staff distributed over twenty stations, as here, the staff in America travels with the trains, and the stations, buildings, and equipments are consequently of a minor character. On the other hand, whenever it is desirable to set down or take up a large or small number of passengers at a given spot not usually worked to as a station, nothing is necessary but to stop the train, like an old stage coach, and the requisite station staff is forthcoming. There are many places where there is a market traffic once a week, for which a fixed station staff would be required on such occasions, and with the privilege of keeping their hands in their own pockets, and dipping into the pockets of the shareholders the greater part of the week, and which must in England be neglected or worked at a loss. Of course, a staff proportional to the trains will, nevertheless, be at times in excess of the traffic, but by no means correspondent to a fixed station staff.

The element of cost, we have frequently had occasion to point out, is the foundation of traffic working, upon which depends the relation of returns to expenditure, and to a great degree the realization of a dividend. It is true enough, that where there is an enormous traffic it may be able to meet an enormous outlay for construction; but on the other hand, a moderate outlay is safer to receive a return.

We have shown that the length of line in New York State is far above our standard, and we may observe that it brings a very handsome return, and this in a thinly peopled country. The whole cost, however, of 1819 miles is $84,034,456. For the reduction of the various sums from American to English values, we shall take the dollar at 50d.; that is, the cent at one halfpenny, which is sufficient to meet the requirements of the case, and which will give us as the whole cost 17,500,000*l.* The average cost per mile of a single line of rails is $36,701, or 7500*l.* Upon the question of comparative cost, we shall not now dwell, only so far as it influences the question of fare.

It is obvious that lines costing 7500*l.* per mile can carry much cheaper than lines that cost five or eight times as much, unless the latter are qualified to carry a greater traffic. A double line effects this, but still there is the difference between 15,000*l.*, the American standard for a double line, and the much larger cost of most of our English lines. We take the cost of a double line at double the single track, which we believe is about fair in the United States. If then a double line in the United States would cost 15,000*l.*, it can carry at one-third the fare of a line costing 45,000*l.*, and pay as good a profit, and it is this question of fare which, as a further step in the progress, influences traffic.

The working of a limestone quarry is as good an example for working out traffic sums as can be found. Taking the cost of the limestone at five shillings per ton, and the price which the farmer or other consumer can afford to pay, or that which is limited by competition, to be ten shillings, then five shillings remaining for cost of conveyance, the distance to which the lime can be carried will be limited by the rate of conveyance. If the rate be sixpence per mile, then the stone can be carried only 10 miles; if threepence, 20 miles; but if one-penny, then 60 miles. To the carriers

it may seem indifferent whether they carry the stone ten miles or sixty, seeing that they receive in either case five shillings; but if they truly look at their interests, it will suggest itself that the lowest fare which is remunerative to them is the one which will bring the greatest return. With a distance run of ten miles, the area of consumption and distribution will be over a circle of ten miles radius, or 20 miles diameter; but with a distance run of 60 miles or 120 miles diameter, the area would be vastly increased. Practically, of course, the whole theoretical area is not obtained, because there are natural or other bounds to traffic. Thus, in the case cited, a neighboring stone quarry will constitute a bound at five miles' distance, though in other directions the radius may extend to 60 miles. The object, therefore, practically, is so to adjust the rate of conveyance as to secure the maximum amount of income and of profit. We need scarcely say that traffic managers in this country are seldom guided by such considerations. At one time they put on prohibitory high rates on articles which will not bear them; at other times they engage in foolish competition with other companies, and put unremunerative rates on articles which can bear any amount of charge, and do not feel the benefit of the reduction.

With regard to passengers, applying the above principle is equally applicable, though the form is varied. Traffic managers can understand that coal and limestone are influenced in their consumption by the rate of charges, inasmuch as they proceed from a place; but they do not seem to understand the converse, how when the traffic goes to a place, the same law operates. Let us take the case of Birmingham or Cheltenham. The consumption of Birmingham goods is general throughout the country, and the tradesman will resort to Birmingham if he can do so with advantage to himself. This depends upon the rate of fare added to his other expenses, and being part of the margin of profit or loss on his operations. If ten shillings be the amount which he can afford to spend on traveling to Birmingham, he will travel so far as ten shillings will carry him, and this depends on the railway companies; beyond that sum he will not travel at all. Pleasure traffic is not of the same precise nature, but is dependent on the same general law, and the area of the Cheltenham traffic is as much dependent on the rate of railway fare as its yearly fluctuation is on the state of the country.

It will be seen that from certain districts a railway will receive no income at all, nor can it receive any unless its rate of fare will make it remunerative or practicable to the traveler. The hardwareman or ironmonger will visit Birmingham, Sheffield, or Wolverhampton, and the clothman will visit Leeds or Bradford, if his transactions will bear it, and not without; and we need scarcely say that as matters stand, the tradesman in the north of this island, or in the provinces of the sister island, does not think of visiting the places named for purposes of business.

The development of passenger traffic affects goods traffic in most articles, and the two work together, so that moderate passenger fares are of more importance than moderate goods rates. Coal, it is true, may be sent to market in hundreds of thousands of tons with little personal supervision; but all kinds of merchandise and parcels traffic require much personal intercourse, and this, notwithstanding cheap rates of postage and

telegraph communications. Looking at all these circumstances, we cannot but feel that railway traffic in this country is far from bearing its full results, and has not reached a complete development.

The traffic of the United States rests, it will be seen, on a sound basis, so far as the cost of line is concerned, for it is not difficult to get a traffic for a line costing 7500*l.* a mile, even though the per centage of working should prove very high. Upon such a cost we may expect low fares, and indeed we find them.

On a very few lines in New York, and those short ones only, do we find a first class fare of 1½d. This is the maximum, and seems to be an enormous rate. The ordinary first class fare is our parliamentary one of one penny per mile. What do our chairmen and shareholders, who exclaim against parliamentary trains, and call out for high fares, think of that? Let them imagine, if they can, the practicability of working a railway at such fares, paying 6 to 7 per cent. on debenture debt, and higher dividends. Incredible as they may think it, it will be done in these countries as well as by our brethren beyond the Atlantic, and although engineers pronounce it impossible to make cheap lines, there will be plenty of them before many years are over.

Second class fares, properly speaking, are not found on most of the lines, the first class fares being so moderate that a uniform rate can be charged, and there is no necessity to talk of turning decent coated men out of second or third class carriages, adopting dirty tricks to prevent the public from traveling according to their means, or for turning mechanics and their wives into hog-pens. The lower class fares are chiefly for emigrants and negroes, and they go down low enough in all conscience. A great quantity of traffic is carried at 0·50d., 0·48d., 0·40d., and even at 0·37d. Here are rates for the consideration of traffic committees, though perhaps gentlemen who hold their hundred thousand pound stock in one line may not believe that there are persons among their fellow countrymen to whom a few shillings are as great an object as their guinea attendance fee is to them.

Let it not be imagined that the American lines are only short lines, having no scope for through traffic. They have short lines, it is true, upon which generally the highest rates are charged; but they have lengths of line in comparison with which our London and North-Western route falls into the shade. The New York and Erie Railway, in its main line, from Piermont to Dunkirk, is 446 miles long, or nearly as far as from London to Perth. The lowest fare from London to Perth, 452 miles, is 30s., and this is likewise the lowest fare to Edinburgh and Glasgow, 405 miles. The third class fare on the New York and Erie Railway is 15s., or half that amount. The first class fare is 37s., or little more than that amount, so that wealthy and working classes are equally well treated. The first class London and North-Western to Perth is 79s. 6d., and the express 87s. The New York and Erie ordinary rate, including stoppages, is 21 miles; what the London and North-Western is for third class passengers to Perth, we cannot make out; that for first and second class passengers seems to be about 22 miles per hour. The New York and Erie express rate is 27 miles, including stoppages, and the fare only first class fare. The London and North-Western rates to Perth are 26 miles and 30 miles

per hour, the fair as above given; therefore, we have not much to boast of in the way of accommodation. It is not to be wondered at if the average mileage of a New York passenger is twice that of an English passenger.

A peculiarity on some of the American lines is, that they charge higher rates for intermediate, or, as they call them, way passengers. This is on account of the greater average mileage.

On Improved India Rubber Springs for Railway Engines, Carriages, &c.
By Mr. William C. Craig, of Newport.*

In order to explain the difficulties which have been contended with and surmounted by the use of these springs, the condition of the roads upon which they have produced such satisfactory results has to be noticed, and the causes which first led to the introduction of india rubber as a substitute for steel, in bearing springs, buffers, and draw springs.

The Western Valleys Lines of the Monmouthshire Railway and Canal Company (upon which the writer is locomotive superintendent), consist of twenty-five miles of tramway, exclusive of branches, and worked by heavy coupled engines of the most improved construction. The tram-plate is laid by means of chairs upon transverse sleepers, about 3 feet apart, and an intermediate sleeper at the joints. This plate, although heavy (about 73 lbs. per yard), is of very weak section, and there is, consequently, considerable deflexion in it, a tendency to rise at the joints, and for the sleepers to work loose: the effect of this is, to cause a much greater expenditure of power necessary to overcome a series of rising and falling gradients, than would be the case upon an edge rail; and an undulatory motion of the engine is caused, which is extremely destructive to the steel springs hitherto in use on this line. The curves are unusually sharp, (some being under five chains radius, and the majority under twenty chains,) which is productive of a prejudicial effect on the wheels, buffers, and other parts of the engines, carriages, and wagons. The gradients are very heavy, (some being 1 in 54,) producing a much greater strain on the draw-bars and couplings than is to be met with upon ordinary railways.

Upon such a road, the inconveniences attending the use of steel springs were both numerous and formidable. In addition to the continual repairs which were required by the springs themselves, the injury done to the permanent way, arising from the unequal action of the spring, and the violent concussions they were subject to, when they were totally disabled (as was frequently the case), was large in amount, and of continual occurrence, and of a character that involved considerable expense in repairs. Some idea of the damage thus occasioned may be formed, from the fact of the wheels tyres requiring to be replaced at least every eight months, having become worn by that time into a series of flats, more nearly resembling an irregular polygon in outline than the circumference of a circle.

The engine tyres used on the tramways are steeled on the wearing surface. With regard to the springs themselves, it may be proper to mention here, that the item of expenditure for steel springs (including wages for

* From the London Repertory of Patent Inventions, July, 1853.

repairing them) was 251*l.* 9*s.* 9*d.* in six months, for fifteen engines only. Such, then, were the circumstances when it was deemed necessary to test the application of india rubber to the various purposes before mentioned, and the results have been attended with such marked success, as to exceed the most sanguine anticipations entertained.

The india rubber springs described in this paper are constructed on Mr. Coleman's plan; one form of which, as applied to engine-bearing springs, consists of a cylinder of prepared india rubber, 9 inches long and 9 inches in diameter, with a hole through it of $1\frac{3}{4}$ inch for the spring pin; it is supported by a wrought iron plate $1\frac{1}{8}$ inch thick, which rests on a shoulder on the spring pin, and is covered by a wrought iron plate and cross-bar, through which pass the spring links attached to the outside framing at the bottom, and secured by set and jam nuts at the upper end. The india rubber is prevented from undue lateral expansion by two $\frac{3}{4}$-inch round iron hoops, and from internal compression and friction on the spring pin, by a helical coil of strong wire; instead of this wire, wrought iron ferrules are now used. To obviate an inconvenience which has been occasionally complained of, in passing over unusually rough portions of the road, viz: the jumping motion of the engines, from the great elasticity of the springs, it was found necessary to insert between the bottom plate and the top of the framing, another smaller cylinder of india rubber, for the purpose of absorbing the recoil of the spring, and to prevent any motion being re-communicated from the spring to the framing. This had the desired effect, and the engine was found afterwards to run uniformly steady, at all varieties of speed, and however great the inequalities of the road.

Upon engines with inside framing, or where sufficient space for the springs could not be obtained, two cylinders, or sometimes three, were used.

In the application of the same description of spring to a tender, the india rubber is $6\frac{1}{2}$ inches diameter, 7 inches long, with a $1\frac{3}{4}$-inch hole, and bears against a cast iron bracket bolted to the frame work of the tender—the bottom plate being supported by a set nut on the spring pin, which passes loosely through a hole in the under side of the bracket, and rests on a wrought iron plate, $\frac{5}{8}$ inch thick, made to fit in the top of the axle-box,

A similar arrangement may likewise be applied to wagons. In the passenger carriages, two of these springs are used in pairs, in order to obtain a greater amount of elasticity, without increasing the distance between the centre of the axle and the sole bar, and a modified form of axle-box is introduced, to meet the requirements of the double cylinder of india rubber. No horn plates are used in this case—their place being supplied with two guide-rods, which pass through the axle-box and india rubber cylinders, and are firmly bolted to the sole bar by jaws on the upper ends, and kept in their places by diagonal stays at the lower ends. The axle-box is cast with a projecting hollow wing on each side, which is enlarged on the top, to afford a bearing for the bottom of the india rubber cylinder, and leaving a capacious grease-box between them. The upper ends of the india rubber cylinders are received into a cast iron plate, fixed to the sole-bar; and the arrangement of internal coil, or fer-

rules, and external hoops, is the same as previously described, with this exception, that one binding hoop only is used on each cylinder, instead of two, in the case of wagons—rather greater elasticity being required for carriages. Some new passenger carriages, with this description of spring, are now in use on the Monmouthshire Railway.

The present improved form of engine-bearing springs is termed the "hydro-pneumatic springs." The object of this form is to obtain the same amount of elasticity with a less quantity of india rubber, and is accomplished by thinning the cylinder of india rubber internally; and, in the increased space thus obtained, placing a quantity of fluid—water is used for this purpose—which, acting by hydrostatic pressure, distributes the pressure equally over every part of the internal surface; thus obtaining a much larger bearing surface than if the pressure were confined to the ends, and in fact producing precisely the same effect as a solid homogeneous cylinder of india rubber. The fluid does not entirely fill the cavity in the india rubber, at least not when first put in, but is adjusted to do so only on the spring receiving the maximum of impact: the air at the same time, which had before occupied the space left vacant by the fluid, retires into a chamber for that purpose in the upper part of the casting, and being then in a state of considerable condensation, exerts a powerful elastic force, assisting the spring to regain its equilibrium. The air and fluid are prevented from escaping under the ends of the india rubber cylinder, by that part of the casting which receives them being cast with a groove; so that on the application of pressure, the india rubber forces itself into the minutest crevice, and a perfectly tight joint is obtained without the necessity of interposing any other substance.

A spring, on this principle, is applied to wagons, being of very simple construction, and one that requires no alteration of horn-plates or axle-boxes; but which, with very little labor, may be applied to any existing wagon adapted for steel springs.

The same spring is applied to some new engines now being made for this railway. In this case the spring is entirely beneath the foot-plate, in a hollow part of the framing, immediately above the axle guides, by which great compactness is obtained with increased strength of the frame. The internal arrangement is the same as the hydro-pneumatic spring; but the spring piston is cast in one piece with the axle-box; thus avoiding the necessity of using a spring pin, and at the same time dispensing entirely with suspending links, nuts, and bolts—thereby still further reducing the total weight of the spring, which in this case is brought to a minimum.

In constructing buffers, the elasticity of a cylinder of india rubber is combined with that of a colu : n of enclosed air. No fluid is used in this case, the position of the buffer and its mode of action not being favorable to its use; neither is it required, as buffers should be sensitive, more so than would be the case were fluid used. Transverse pins, riveted to the external or wrought iron cylinder, serve to confine the fixed and moving part of the buffer, and pass through slots in the plunger to allow them sufficient play. In a cheaper form of this buffer, the external wrought iron case is replaced by a cast iron one, for use where not liable to severe cross strains; the first form referred to being only for extra strong buffers.

Draw springs, for the buffer plank of an engine, and for common wagons, are constructed on the same principle, and only differ in their form and getting up.

The advantages resulting from the use of these springs may be thus enumerated:

1st, Reduction of dead weight. This item is more extensive than appears at first sight, since the reduction of weight is not confined to the springs themselves, but extends, in a greater or less degree, to a variety of other parts of the engine, carriage, or wagon, on account of the smoothness of their action. This is particularly advantageous in the case of cast iron, whose liability to fracture consists, not so much in the weight it has to carry, as its inability to resist strains, jerks, and concussions; these are, however, nearly altogether deadened by the use of these springs; so that a motion uniformly smooth and steady takes the place of one that is very injurious to railway plant, especially to engines; and as the working portions of an engine are made extra strong, with a view to resist the concussions they are subject to with steel springs, it follows that when these are no longer allowed to operate, they may be made lighter without in the least impairing their efficiency. The reduction in the springs themselves is, however, considerable, and the weight thus gained is valuable, particularly in the case of wagons, where it becomes available for tonnage. The amount of this reduction of weight varies, as shown by the following table; but may be taken on an average at from $3\frac{1}{2}$ to 5 cwt. per engine, and the same for wagons.

Comparative Weight of India Rubber and Steel Springs.

Weight of Springs.	India-rubber.	Steel.	Reduction in Weight.
Engine-Bearing Springs.	Cwt.	Cwt.	Cwt.
India rubber, $1\frac{1}{4}$ cwt. } Iron Work, 3 cwt. }	$4\frac{1}{4}$		
Steel Springs taken off,		$8\frac{1}{2}$	$4\frac{1}{4}$
Engine Hydro-Pneumatic Springs.			
India rubber, 1 cwt, } Iron Work, 6 cwt, }	7		
Steel Springs taken off,		$8\frac{1}{2}$	$1\frac{1}{2}$
Tender Bearing and Draw Springs.			
India rubber, $\frac{3}{4}$ cwt, } Iron Work, 2 cwt, }	$2\frac{3}{4}$		
Steel Springs taken off,		11	$8\frac{1}{4}$
Carriage Bearing, Drawing, and Buffing Springs,	$4\frac{1}{2}$		
Steel Springs taken off,		$9\frac{3}{4}$	$5\frac{1}{4}$
Wagon Bearing, Drawing, and Buffing Springs,	$3\frac{1}{2}$		
Steel Springs taken off,		$8\frac{3}{4}$	$5\frac{1}{4}$

2d, Steadiness of motion. This has been referred to before; and it may be added that the great steadiness of the engines with the india rubber springs is the surprise of every one who has witnessed their performance upon the imperfect road on which they are worked.

3d, Durability. Although sufficient time may not have elapsed to test the absolute durability of these springs, yet during the time they have been in use, in consequence of the heaviness of the work, if deterioration had commenced ever so slightly, it would have been observable; but in a large number of the india rubber cylinders that were examined, after being at work for various periods, varying from four to six months, in both engines, carriages, and wagons, in no instance was the slightest alteration visible from the day in which they were first used, nor the slightest permanent contraction in length or expansion in diameter perceptible: it may, therefore, be inferred, that their durability far exceeds anything hitherto applied to the same purpose, and is fully equal to any reasonable expectation or requirement. The specimens shown to the meeting, having been in use for the last five or six months, corroborated this statement. The weight of each pair of the engine springs is from 4½ to 9¼ tons.

4th, Saving in repairs. The simple construction of these springs renders it almost impossible for any injury to happen to them; consequently little or no repairs are needed. As stated before, the cost of repairing the steel springs of fifteen engines, for six months, was 251*l.* 9*s.* 9*d.* The cost of repairing the india rubber springs of fourteen engines, during the last six months, was only 1*l.* 18*s.* The saving in the cost of repairs is not confined to the springs alone, but the engine itself; the carriages and wagons to which they are applied, and even the permanent way, share the advantage. It is found that fewer chairs are broken, fewer rails (plates rather) are bent, less grease and oil are used for the bearings, and the cost of maintaining the wagons is reduced when india rubber is used. It is inferred, with a considerable degree of probability, that, from the absence of any jerk upon the axles, the tendency of the iron to become crystallized or altered in its nature, and suddenly fracturing, so often complained of, and which has produced so many serious accidents upon railways, will, by the use of these springs, be nearly overcome, and the axles remain perfect for a much longer period; more especially as under the india rubber springs they show no tendency to heat.

5th, Cost. The question of first cost does not properly belong to this paper, but it will be sufficient to state that a well constructed india rubber spring ought not, in any case, to exceed the cost of a steel spring of equal strength; but on the hydro-pneumatic principle it will be found to be considerably cheaper, especially for engines, amounting, on an average, to 20 per cent. saving on the old plan.

The foregoing remarks have been made chiefly with reference to bearing springs; but they apply equally to both buffer and draw springs; and in proportion to the extent in which india rubber is used in place of steel, does the improvement in the rolling stock become apparent, and the benefit resulting from its use more strongly develope itself. The pneumatic buffers, it is considered, have been subjected to a peculiarly severe test, few lines of railway in the kingdom possessing such disadvantageous circumstances. Almost every other description of buffer had been tried previously with the same want of success, until, from repeated failures, the attempt to obtain a permanent buffer was almost abandoned in despair, and solid blocks of wood were substituted for them in many in-

stances. With these buffers, however, no failure has taken place, nor in any instance has their elasticity diminished in the slightest degree. In the accompanying table, the deflexion of this description of buffer and the several kinds of springs, under different weights, is shown:

Table of Deflexion of Springs.

Load.	Engine single spring.	Engine triple spring.	Engine hydro-Pneumatic	Wagon spring.	Buffer spring.	Draw spring.
	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
½ ton.	5-6	¼	⅜	⅛	3-16	1
1st ton.	½	½	⅛	1¼	¾	1½
2d "	¾	½	¼	⅜	⅜	1
3d "	⅜	⅜	¼	½	3-16	⅜
4th "	⅜	¼	1-16	—	⅛	—
5th "	⅜	¼	1-16	—	3-16	—
6th "	⅜	—	—	—	3-16	—

Before the application of india rubber draw springs to the engines and tenders, the couplings were frequently breaking, and also the frame ends; but since their adoption nothing of the kind takes place. Such are the advantages of these springs, that their adoption promises to become general, and it will be shortly, without doubt, as rare to meet with a wagon unprovided with a draw spring, as it was formerly to meet with one.

In working 15,000 miles, the cost of repairs is found to be reduced in the engines using india rubber springs, in corresponding engines of the two classes, from 5¾*d.* to 3¾*d.* per mile, and from 7*d.* to 3¼*d.* per mile.

It has been the writer's object in this paper to state rather what has been done than to speculate on what will be; but it is notorious that the ordinary steel springs are deficient in point of general efficiency, whether as regards elasticity, durability, or cheapness. It may be that competition may cause their manufacture to be less strictly attended to than formerly; or it may be, and most likely is, that the requirements of the present day have outstripped their ability to perform. However, be that as it may, it is well known that a substitute which shall combine the above requisites has been long desired; and the writer's hope, therefore, that this desideratum will now be supplied by the springs which have been described, must be his apology for bringing the subject before the Institution.

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Mr. Craig exhibited a set of the different descriptions of india rubber springs described in the paper, and also specimens of the india rubber cylinders, taken out of various springs which had been at work on the Monmouthshire Railway, to show the effects of wear upon them. One cylinder had worked 8650 miles in the bearing spring of an engine; another 14,060 miles in a carriage bearing spring; and an engine buffer spring that had been six months in constant use was shown; all of these appeared uninjured by the work, and not to have suffered any permanent compression.

Mr. H. Wright observed that he had seen these india rubber springs

at work on the Monmouthshire Railway, and they certainly worked very satisfactorily, and were much better adapted to that situation than steel springs. The case of that railway was very peculiar; it was perhaps the worst in the kingdom for destructive action on the springs, from the great inequality and roughness of the road, which was not upon the edge-rail, but the old tramway system, and with very sharp curves; it was, indeed, impossible for steel to stand in the engine springs; but the india rubber springs appeared to stand the work well.

Mr. W. A. Adams said he was acquainted with these india rubber springs, and had witnessed their working on the Monmouthshire line; it was previously impossible to keep steel springs in order, from the violent jerks they were subjected to, and the substitution of india rubber for steel in that case was an important improvement. As to the general application of india rubber springs, there was a special circumstance in favor of their use in locomotive engines, from the confined position and the want of space to fix a properly proportioned laminated steel spring, which might probably be otherwise made to work satisfactorily; but the steel springs generally used in locomotives were so short and stiff, that their elastic action was exceedingly imperfect, and they were consequently ill suited to withstand the violent concussions of a rough road. In the bearing springs of carriages the case was very different; and a long, thin, laminated spring was employed, which had a very easy, elastic action; so that in that case the advantage would be less felt of the substitution of india rubber for steel. In applying the india rubber springs to carriages, it had to be observed that the bearing of the frame would be on four points only, instead of eight—requiring a stronger frame or cross-bars to distribute the strain.

Mr. Allan said he had made some trial of these india rubber bearing springs on engines, and they worked very well; but he found them too elastic, and liable to produce a jumping action; but the springs he had tried were of the kind first described, without provision for checking the rebound of the spring.

The Chairman inquired whether, if such reaction could be removed, the india rubber spring would be considered superior to steel?

Mr. Allan thought that very little friction or resistance would be sufficient to check the reaction; and the india rubber would then certainly make a very good spring.

Mr. Craig observed, that the rebound complained of was quite stopped by the little resistance offered by the small second spring that had been subsequently introduced; but it was now found that the objection was quite removed by the water application in the new compound spring.

Mr. Clift inquired whether any difference was found between winter and summer in the action of the india rubber? whether there was any more oscillation observed in hot than in cold weather? and whether the india rubber was liable to any injury by the heat to which it was liable to be exposed from the boiler or fire-box of the engine?

Mr. Craig replied, that the india rubber was not affected by the temperature, and no effect was found during the last severe winter; also, in two tank engines, one pair of the india rubber springs was exposed to great heat, probably as much as 240°, being very near the fire-box, but

there was no perceptible effect. The material used for the springs was Moulton's prepared india rubber; the raw gum would not stand exposure to heat, and the constant compression and elastic action.

The Chairman inquired what pressure there was upon the india rubber when the springs were at work?

Mr. Craig replied, that the vertical pressure on the end of the india rubber cylinder, in the engine bearing springs, amounted to about $1\frac{1}{2}$ cwt. per square inch; a weight of $4\frac{1}{2}$ tons being supported on a cylinder 9 inches diameter, having a $1\frac{3}{4}$-inch hole in the centre. In the hydro-pneumatic spring the pressure on the india rubber was about 2 cwt. per square inch; he intended trying the exact pressure of the water with a Bourdon's pressure gauge, but had not been able to complete the experiments in time for the present meeting.

Mr. E. A. Cowper observed, that he understood a considerable trial of india rubber springs had been made on engines upon the London and North-Western Railway, and inquired what kind of spring had been applied there, and what were the results? He had also heard that on the Great Western they used india rubber springs, and now never hung an engine any other way.

Mr. Craig replied, that the springs tried on the London and North-Western were with two or three cylinders of india rubber, similar to the first arrangement described, and they were working very satisfactorily, and, he believed, were preferred to steel springs.

The Chairman inquired the relative cost of india rubber and steel springs?

Mr. Craig said, that the cost of the india rubber springs did not in any case exceed that of steel. Wagon springs were about 3*l.* 18*s.* per set; but engine springs were considerably less expensive than steel, there being so much greater proportionate weight of steel in the ordinary springs. By the introduction of water in the improved springs, the quantity of india rubber to support the same weight was reduced from 20 lbs. to 12 lbs. in each spring, which, at the cost of two shillings per pound, effected a considerable saving in the expense. A considerable saving in respect of grease had also been observed; but not being able to give the exact results, he would make a comparative trial for the purpose of determining that point.

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*Railway Traffic in Great Briain.**

The traffic returns of railways in the United Kingdom amounted for the week ending 28th May to 326,900*l.*, and for the corresponding period of last year to 287,903*l.*, showing an increase of 38,997*l.*, or 13·54 per cent. The gross receipts for the eight railways having their termini in the metropolis amounted for the week ending as above to 154,438*l.*; and for the corresponding week of last year to 137,545*l.*, showing an increase of 16,893*l.*, or 12·3 per cent. The increase on the Eastern Counties Railway amounted to 1094*l.*; on the Great Northern, to 3390*l.*; on the Great Western, to 2316*l.*; on the London and North Western, to

* From Herapath's Journal, No. 730.

1504*l.*; on the London and Blackwall, to 310*l.*; on the London, Brighton, and South Coast, to 5144*l.*; on the London and South Western, to 793*l.*; and on the South Eastern, to 2342*l.*; total, 16,893*l.* The receipts on the other lines in the United Kingdom amounted to 172,462*l.*; and for the corresponding period of 1852, to 150,358*l.*; showing an increase of 22,104*l.* in the receipts of these lines; which, added to the increase on the metropolitan lines of 16,893*l.*, makes the total increase 38,997*l.* over the corresponding week of 1852.

The total increase in the traffic from the 2d January to the 28th May, over the corresponding period of 1852, amounted to 653,805*l.*, or 11·8 per cent.

Description of M. Maus' Plan for forming a Tunnel through the Alps; and of his Excavating Machine for Tunnelling. By Wm. H. V. Sankey.*

In my former communication (p. 670, vol. x.) I stated that I hoped to obtain information from the Chevalier Maus concerning his plan for forming a tunnel through the Alps. Having since been favored by him with full particulars relating to his project, I now send you a statement of the manner in which he proposes to effect the great object he has in view, prefacing my account with a short description of the route he considers it best to adopt, and a few other particulars in connexion with the subject which may be interesting to your readers.

The line of communication selected by M. Maus skirts the southern side of the Mount Cenis, following the valley of the Dora, and passes by the towns of Susa, Oulx, Bardoneche, &c., thence by means of a tunnel under the ridge of the Alps it proceeds to Modana, a town situated in Savoy, on the west of that extensive chain of mountains, by a route only 30 miles in length; while the existing public thoroughfare over the Mont Cenis pass is nearly 40 miles, so that a saving of about 10 miles would be at once effected between Susa and Modana; and the time required to travel between these two places would, in the event of this project being put into execution, be reduced from eight hours (the time which the mail takes to go by the present road) to one hour and a half, a very moderate calculation for the railway—being only at the rate of twenty miles per hour.

Thus the portion of the great Savoy trunk line of railway, projected by M. Maus, would commence, on the Italian side, at the town of Susa, near the confluence of the Dora with the Cenisis, a rapid stream that takes its rise in the Mont Cenis; and would form a continuation of the Turin and Susa railway, now in course of construction; the line would then pass to the right of the village of Gioglione and over the high grounds of Chaumont (where the mountainous character of the country involves the necessity of two tunnels, which are, however, of minor importance, the one being about 3040 yards in length, and the other only 330. A short tunnel will likewise be necessary at the Fort of Exilles, in order to avoid some of the outworks, and farther on another tunnel, which, however, will be only 2230 yards long. We thus arrive

*From the London Builder, June, 1853.

at Salbertrand, situated ten miles from Susa and nearly 1670 feet above its level, which gives for this portion of the line an average ascending gradient of 1 in 31. Beyond this, passing Oulx, Savoulx, Beaulard, and even for some way farther on than Bardoneche, the surface of the country is remarkably uniform, and will not present any difficulty: the length of this section is about eleven miles, and its average rate of inclination 1 in 57. The remaining nine miles is a descending gradient of nearly 1 in 57, likewise. And here the line obtains a passage beneath the Alpine ridge by a tunnel of about eight miles in length, at a depth of 5248 feet, or as nearly as possible a mile below the surface of the pass.

The three principal gradients above mentioned being divided into others, to suit the nature of the ground, the rates of inclination on some portions of the line will be steeper in certain cases than those named, but in no instance will they exceed 1 in 28. Throughout the whole length of the principal tunnel the gradient will be 1 in 53.

M. Maus estimates the cost of the work as follows:—

For forming a heading with a machine invented by him for the purpose,	£180,000
For increasing the size of this heading, so as to form a tunnel in the usual manner through a lias rock, containing scales of mica and grains of quartz, of so compact a nature as not, apparently, to require any facing in masonry, ...	370,880
	£550,880
For the remaining portions of the line forming approaches north and south of the proposed tunnel, viz:	
Cost of land, ...	26,019
Earthwork, ...	181,366
Bridges, culverts, &c., including the several shorter tunnels above alluded to, ...	468,448
Rails, chain, sleepers, &c., ...	171,969
Total, . . .	£1,398,682

Say £1,400,000 altogether in round numbers.

As the projector considered that the great difficulty in the way of carrying out this bold conception would be the amount of time and labor which, according to our present system of conducting such operations, it would necessarily require, he has contrived an excavating machine, for facilitating the labor, and which, at the same time, is calculated to expedite in a very great degree the execution of this and similar works, and from the success which has attended the trials he has already made with it, he states that he has no hesitation in fixing five years as an amply sufficient period for the completion of the projected tunnels, working at both ends at the same time, although without shafts, which the height above renders impossible.

The excavating machine consists of a frame, in which are set a number of very broad chisels, having projections on their face, acting somewhat after the manner of the hammer used by masons to restore the rough surface to the granite pavement in London when worn smooth by the traffic.

The chisels are so arranged as to cut into the face of the rock, at the extremity of the heading, five horizontal grooves, and two vertical channels bounding the former, and at right angles thereto. These grooves

or channels are run one into the other, and serve to insulate four rectangular blocks of stone, which will then remain attached only by one of their planes to the solid mass of the mountain rock, from which they may readily be separated by wedges, driven with heavy hammers into the grooves.

These blocks will be about seven feet long, three feet wide, and eighteen inches in thickness.

The machine acts only upon half the width of the heading at a time, so that while it is at work cutting the grooves, which separate the blocks of stone at one side, the workmen are engaged in removing those already cut in the other half-width of the heading.

When the machine and the laborers have each completed their tasks, they mutually change places. The machine again sets to work to shape out new blocks of stone, and the workmen proceed to detach those which have just been cut, beginning by inserting the wedges at the top of the heading, and proceeding downwards; by thus prizing the stones, they are easily separated from the rock, after which they are placed on trucks, and conveyed to their destination, so that the space is again left clear for the machine to recommence its operations.

The excavating machine cuts the channels in the rock, by means of several series of chisels placed one beside the other, in straight lines; these lines of cutting tools are so arranged as to be capable of a slight lateral motion in the direction of the grooves after every stroke; the object of this is to bring the chisels to bear upon all the spaces lying between the several cutting tools situate in the same line, so as to produce not a succession of holes, but a continuous channel similar to a very wide saw cut.

This lateral shifting of the lines of chisels, which takes place alternately from right to left, and from left to right, is caused by a corresponding motion given to the frames in which they are fixed. Each chisel is driven against the rock by a spiral string coiled round it, and which produces an effect similar to that caused by the muscles of a man in the act of throwing a javelin. This spring, driving the chisel forcibly against the rock, obliges it to act efficaciously, notwithstanding the slight inequalities at the bottom of the channel, arising from a want of uniformity in the resistance of the stone.

When the machine is in operation, the several lines of chisels are all drawn back simultaneously, by means of a species of cam, or movable bar, which acts against projections formed on the cutting instruments. This, by forcing back the chisels, and thus compressing the above mentioned springs, leaves them in a position to exert a strong percussive force as soon as the pressure is removed. This is effected by suddenly raising the bars, by means of an inclined plane, situated at the proper place for the end of the stroke. As soon as the blow has been struck, the springs are again immediately compressed, as before, and the process is continued until grooves have been worked to the requisite depth into the solid substance of the rock.

Although all the chisels in each row are similarly acted upon by the movable bar, they are, nevertheless, completely independent one of the other, so that they may each be removed at pleasure, without interfering

with the motion of those adjacent, or even suspending the operations of the machine; and if it be observed that one or other does not act efficiently, such may be removed, and new chisels substituted in their stead, without causing any delay or cessation.

The back and forward motion of the bar, which performs the functions of a cam, by pushing against the projections with which the several chisels are furnished, is caused, through the intermediation of rods and cranks, by two rotary drums, which themselves are made to turn by an endless rope, communicating with a water wheel, or other suitable motive power, situated at the entrance to the heading. The apparatus is arranged so as to enable the chisels to strike 150 blows in a minute.

The machine, at the same time, sets in motion a pump, which forces a constant supply of water into a reservoir, the upper part of which is filled with compressed air. By this means, the water is driven out in jets, through small pipes placed between the chisels, and is thus made to play upon the grooves, where it performs the double office of preventing the cutting instruments from getting heated, and removing the dust and chips of broken stone, which would otherwise accumulate in the grooves, and thereby prevent the effective working of the excavator.

The idea that suggested this substitute for manual labor in one of the most tedious of engineering operations is extremely ingenious, and the inventor of this piece of mechanism, which in my opinion is destined, in a short time, to become of general utility, is deserving of the highest credit. I must frankly own that I was not sanguine of its success previous to having examined it; but since I have heard it described, and seen how it works, I feel no hesitation in saying that it will, ere long, be applied to facilitate mining and quarrying operations, and will become extensively used in the carrying out of railway and other works.

I have no motive in extolling thus highly this invention, further than a desire to see introduced and tried on a large scale a mechanical contrivance which recommends itself on account of its extreme simplicity, and very especially because it may be considered the forerunner of a class of automaton laborers which cannot fail to benefit society, inasmuch as they inevitably tend to diminish human toil, and thereby will have the effect of raising the working man in the social scale, and enabling him to find leisure to cultivate his mental faculties; while, at the same time, it will afford increased encouragement to the progress of industry, and will enable us to undertake and prosecute successfully many splendid and important engineering projects which, without its aid, we should not even have dreamed of.

The manner in which the engineer proposes to provide for a proper supply of fresh air during the progress of the work is by means of a tubular ventilator, which he intends to lay along the bottom of the gallery. At given intervals throughout its entire length, according as they may be found necessary, he would insert fans, which he suggests might be placed on the spindles or shafts of the rollers or sheaves over which the endless rope is made to pass, so that they could constantly be worked with very little additional expense. These fans would force the air from one chamber of the tube into that immediately succeeding it, and as the ventilator would be made air-tight throughout its whole length, and

only open at its extreme ends, so that the air introduced through the tube may pass out through the heading, he considers that a constant current of pure air would thus be continually maintained in the tunnel, which, by its uninterrupted circulation, would cause incessant, successive, displacements as to prevent any possible accumulation of noxious gases or unoxygenated atmosphere.

Since writing the above, I have learned that Mr. Robert Stephenson, the eminent English engineer, when passing through Turin, on his way to Egypt, in the month of September, 1850, went to see the experimental machine then in operation at Valdoc, and M. Maus says he recalls with much pleasure the approbation and encouragement given him by our distinguished fellow-countryman, who, in a letter addressed to the Sardinian Minister for Public Works, stated it as his opinion that it would be advisable for the Government to make a trial of the excavating machine on an extensive scale.

The exhausted state of the Piedmontese exchequer, consequent upon the war with Austria, and the expenses of the great works connected with the line of railway between Genoa and Turin, have hitherto precluded the possibility of putting the invention to the test of practice in the actual execution of the works proposed. Nevertheless, now that the question of forming lines of railway through the Alps is every day becoming of greater importance, the time is probably not far distant when we shall see active measures taken for the realization of this important proposition.

AMERICAN PATENTS.

List of American Patents which issued from August 16, *to September* 6, 1853, *(inclusive,) with Exemplifications by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

AUGUST 16.

38. For an *Improvement in Bedstead Fastenings;* George W. Baynes, Thomas Hinty, and Minter Jackson, Glenville, Virginia.

"The nature of our invention consists in so constructing a bedstead, that one of the tenons being pivoted or swung in a mortise in the rail, free to rise and fall in the mortise of the post, while the other tenon is rigid in its connexion with the rail, may, by means of screws operating on the head and foot rails, securely fasten, not only these rails, but the side ones also, by the same device."

Claim.—"Having thus described the nature of our improved mode of fastening bedsteads, what we claim is, the combination and arrangement of the tenons, *a a*, tenons *d* and *f*, with the screw, B, for the purposes set forth."

39. For an *Improvement in Meat Tenderers;* William Beach, Philadelphia, Penna.

Claim.—"What I claim is, forming a meat maul, for the purpose designed, by securing to one end of an oblong block of wood, whose opposite end is formed into a handle, a series of rows of tapered teeth of the form described, cast on a plate, or driven singly into the wood, as may be desired."

40. For an *Improvement in Hinges for Folding Bedsteads;* John Binder, Chelsea, Massachusetts.

Claim.—"What I claim is, the method described, of constructing a hinge with the circular bearing surfaces, for the purpose set forth."

41. For an *Improvement in Gun Locks;* P. F. Charpie, Mount Vernon, Ohio.

"The nature of my invention consists in connecting the dog of a main spring to the hammer, by means of a screw passing through a curved slot in the lock plate, in combination with suitable packing encompassing the slot on the outside of the plate; by this combination I am enabled to use an extremely simple and useful device for a gun lock, and to place the principal parts on the inside of the plate, fully protected from moisture."

Claim.—"I do not claim the arrangement of the hammer, main spring, and dog, as shown, for that has been previously used, and placed on the outside of the lock plate; but what I do claim is, conducting the dog to the hammer by means of a screw passing through a curved slot in the plate, in combination with the packing which encompasses the curved slot; by which combination I am enabled to place the main spring and dog on the inside of the lock plate, and prevent the admission of moisture within the lock, as set forth."

42. For an *Improvement in Printed Carpets;* Thomas Crossley, Roxbury, Mass.

Claim.—"I am aware that carpets and woolen fabrics of various descriptions have been stamped and printed upon one side, the other invariably being disfigured by the operation; and also, that two and three ply carpets have been printed with the same or different figures upon the two sides, as I have myself received a patent for a carpet so produced, as before stated: I therefore now lay claim to none of these processes; neither is it my intention at present to found any claim upon the method in which I weave my carpet; but what I do claim is, a single ply printed carpet, made by combining the warps and filling in the manner described, and subsequently printing them on one or both sides; I having discovered that fabrics woven in this manner could be printed on one or both sides without the colors passing through, and discoloring or intermingling with the colors on the opposite side of the fabric."

43. For an *Improved Rudder Brace;* Benjamin F. Delano, Chelsea, Massachusetts.

"The nature of my invention consists in the application to the rudder head of a lever or brace, which is permitted to turn freely upon a pintle or centre, projecting from the deck of the vessel, which lever is suitably connected to the rudder head by arms with flexible or hinge joints, by which means the rudder stock is caused to turn freely in the opening in the deck through which it passes, which opening may then be made sufficiently large for the purpose, and thus the friction, straining, and noise, are avoided, and the rudder receives an additional support, rendering it more secure and safe in its position."

Claim.—"Having thus fully described my invention, what I claim is, 1st, The brace, connected with the rudder, substantially as described, and operating in the manner set forth. 2d, The combination of the brace with the elliptical tiller, or any other analogous device, for the purpose of actuating the rudder by the application of power to the braces, instead of to the rudder itself."

44. For an *Improvement in Facing Buildings;* Michael B. Dyott, Philadelphia, Penn.

"The nature of my invention consists in an improved mode of uniting, fastening, and supporting cast iron or other plates to the external walls of buildings, whereby the said plates form an ornamental facing thereto, are protected against external injury, and secured from the injurious and disfiguring effects of moisture from the interior."

Claim.—"I do not claim the facing or securing of stone to the surface of buildings in any manner, or by any means whatever, nor embedding any other substance in mortar or cement upon the surface of walls; neither do I claim the facing of brick walls with iron or other plates, by building them in mortar with the wall, and fastening them by bolts or ties, as I am aware that these things have before been done; but what I do claim is, the method herein described, of supporting a veneering or facing of thin cast iron, or other plates, upon their inside, and uniting the same firmly with the external surface of the building, by so fixing the plates in relation to the wall as to leave a sufficient space between them to allow a cement in a liquid form to be poured in to fill the space and all the interstices of the plate, perfectly solidify around and upon the hooks and other fastenings, exclude the air and all dampness, whereby the veneering is strengthened, protected, and preserved, as fully set forth."

45. For an *Improvement in Machines for Preparing Spoke Timber;* Aaron W. Geaheart, Beallsville, Ohio.

"The nature of my invention consists in so constructing the clamping and guiding or gauging portions of a machine, placed on a seat board, that great exactness may be ob-

tained in getting out spoke timber with the ordinary drawing knife, whereby I effect the saving of three-fourths the labor of the ordinary method heretofore used."

Claim.—"What I claim is, the arrangement of the adjustable bed, the bridle or clamp, the sliding guide or gauge, and foot lever, for the purpose and operating in the manner substantially set forth."

46. For an *Improved Socket for Auger Handles and Braces;* Arahal H. McKinley, Higginsport, Ohio.

"The object of my invention is to provide a convenient device for readily shipping and unshipping an auger, or other boring tool, to and from its handle, so that one handle may serve a great number and variety of tools, and thus save a great deal of room in the tool chest."

Claim.—"I do not claim the enabling the shipping or unshipping of a bit or auger from its stock or handle, that having long been accomplished; but what I do claim is, the peculiar arrangement of mechanism by which I enable the shipping and unshipping of the bit and handle of an auger, or other boring tool; that is to say, the socket having a circular head and vibrating cap whose aperture can be made at one position to coincide with the mouth of the socket, and in the other position to oppose its straight edges to the projecting corners of the shank, the cap being retained in the desired position by a spring and notch, as described, or its equivalents."

47. For an *Improvement in Draft Apparatus of Seed Planters;* Jacob Mumma, Mount Joy, Pennsylvania.

"My improvement in seed drills consists in combining a pole (for the horses) with a supporting and directing wheel, so as to relieve the horses from the strain they incur in other drills, and also to be enabled to run the drill straight forward, or keep it in its course, even if the horses deviate considerably."

Claim.—"What I claim is, the combination of a tongue having motion vertically and laterally with the directing and supporting wheel, substantially as set forth."

48. For an *Improvement in Drop Hammers;* E. K. Root, Hartford, Connecticut.

Claim.—"I do not wish to limit myself to the special construction herein specified, so long as the same effects are produced by equivalent means; what I do claim is, the method of elevating the drops or hammers by means of a screw having a continuous rotary motion, in combination with the mechanism, or its equivalents, for disconnecting the drops or hammers from the screw, to permit them to drop, substantially as described. I also claim the method of disconnecting the drops or hammers, by the rotation of the elevating screw, which is notched to catch and act upon the finger, or its equivalent, connected with the side, or its equivalent, to force it back and clear the thread of the screw, substantially as specified. I also claim, in combination with the slide which connects the drop or hammer with the elevating screw, and with the finger on the slide, or their equivalents, the employment of a catch lever, or its equivalent, holding up the drop or hammer when it is liberated from the elevating screw, and there to hold it until it is required to be dropped, substantially in the manner described. And, finally, I claim, in combination with the slide which forms the connexion with the elevating screw, and with the catch that holds the said slide when liberated from the elevating screw, or their equivalents, the employment of the rebound latch, or its equivalent, which liberates the parts by the rebound, when the drop or hammer strikes, substantially as specified."

49. For an *Improved Trip Hammer;* William Van Anden, Poughkeepsie, N. Y.

Claim.—"I do not claim elevating the hammer shaft by means of cams; neither do I claim the friction rollers, irrespective of the particular manner of arranging or attaching them to the hammer shaft, as herein shown; but what I do claim is, 1st, Attaching a collar to one end of the hammer shaft, said collar working loosely over a shaft which has a spring attached to it, for the purpose of forcing down the hammer shaft. The shaft being provided with a set screw, or its equivalent, and lever, arranged as described, by which, upon properly adjusting said set screw, or its equivalent, the hammer may be made to descend upon the block or anvil with greater or less force, as desired. 2d, I claim the employment or use of the friction rollers attached to a vibrating frame, and arranged substantially in the manner as herein shown, for the purpose of relieving, instantaneously, the cams from the pressure of the rollers, when the highest points of the cams have passed the lowest centres of the rollers, thus preventing the wearing of the cams at their highest points, as set forth."

50. For an *Improvement in Breech Loading Fire Arms;* John P. Schenkl, Assignor to John P. Schenkl and Adolph S. Saroni, Boston, Massachusetts.

"My invention consists in a method of unscrewing the breech from the barrel, and withdrawing the same, of turning up the breech so as to bring its chamber into a vertical position for loading, and then returning the breech into the barrel, and locking the two together, which motions are performed through the intervention of appropriate cams, catches, and springs, by the motion of a single lever worked by the hand of the gunner."

Claim.—"I do not claim uniting the breech to the barrel by means of male and female screws, portions of which are cut away to enable the one to enter the other, the two being secured together by a partial revolution of one of them, as this has been done before; but what I do claim is, the above described combination of parts, for the purpose of operating the movable breech, constructed and arranged substantially as described."

51. For an *Improvement in Hill Side Ploughs;* William Harrison Babbitt, Waynesburgh, Pennsylvania.

Claim.—"Constructing and arranging a head in the hinge which connects the beam of the plough with the upright, so as to lock said hinge by means of a bolt before the pivot of said hinge, and by a lever behind said pivot, for the purpose of making the bearings in said hinge adjustable, substantially as set forth."

52. For an *Improved Screw Wrench;* Aury G. Coes, Worcester, Massachusetts.

Claim.—"I am aware that the movable jaw of a wrench has been made to slide on a shank, by means of a female screw nut placed on a screw cut on the shank, the said nut being so connected with the movable jaw as to be capable of being put in rotation, and of moving the jaw on the shank. I am also aware that the movable jaw has been moved by means of a screw; I therefore do not claim such to be my invention. But what I do claim is, the combination and arrangement of the screw tube, its male and female, or external and internal screws, the screw on the shank, the annulus, and its female screw, as applied to the sliding jaw; the whole being made to operate together, substantially in manner and for the purpose of enabling a person to readily move the sliding jaw on the shank with a velocity compounded of the velocities of motion of two female screws on two male screws, as described."

53. For an *Improved Ships' Block;* William Coleman and Stephen G. Coleman, Providence, Rhode Island.

Claim.—"We claim as our invention, the above described mode of constructing the hook and eye staple of the ship's block, and supporting it within, and by means of the checks, without any extension of it around and in contact with the sheave pin, and whether each of the checks is made whole or in two parts, as herein before specified; and in combination therewith, we claim the mode of sustaining the sheave pin and connecting the two parts of each cheek, viz.: by a metallic rod extending through them, and directly under and against the sheave pin, substantially as specified."

54. For an *Improvement in Machines for Pegging Boots and Shoes;* Alpheus C. Gallahue, Alleghany City, Pennsylvania; ante-dated February 18, 1853.

"The nature of my invention consists in so constructing a machine that the punching of holes, cutting pegs, and driving them by percussion (not forcing) into the soles of boots or shoes, is performed at one operation; and that, instead of moving the machine over and around the work, which is attended with great complexity of machinery and expense, I am enabled to move my work under the operative portions of the machine, and by simplifying the mechanism, greatly reduce the cost, and render practical the operation as applied to all sizes and shapes of the sole, without any change being necessary, except that of substituting one of the ordinary lasts for another."

Claim.—"Having described my improvement, what I claim is, 1st, The sliding lever, (having a hook thereon for entering the staple of the last,) which, passing through slots in the uprights of the turn table, secures the last to said table, by the introduction of the wedge, as set forth. 2d, I claim the turn table, mounted on the sliding table, which works on ways upon the moving table, and is actuated by springs for the purpose of keeping the edge of the sole in contact with the gauge, when this is combined with mechanism for giving the turn table a semi-revolution at the point where its centre is brought opposite the awl by the motion of the table, that regularity in inserting the pegs may be secured. 3d, I claim the combination of the spring, lever 16, catch, or their equivalent, sliding wheels, racks, and mitre wheels, by which a semi-revolution is given the turn table (while

the pegs are being inserted around the heel,) by the slipping of a cog wheel from rack 7 to 6, on the release of lever 16 from catch 3 *s*, and the return of said cog wheel into rack 7, on the release of spring n from catch L, by which means it acts on the upper side of lever 16, as set forth. 4th, I claim the cam, 53, rod, 52, secured to hammer *z*, and helical spring, *f'*, by which a graduated driving stroke is given the awl and its rod, in combination with cam 2, rod *h*, (upon which slide the hammer,) and helical spring *g'*, by which a driving stroke is given the peg driver alternately with that of the awl and its rod; it being understood that I do not claim the general feature of a hammer and rod carrying an awl, and spring for driving the awl, operated by a cam, as this has been done heretofore; but the particular mode or combination in which they are used as here claimed. 5th, I claim giving the peg tube and driver a side motion, independent of the awl and awl rod, by means of cam *o*, and lever A, or their equivalent, for the purpose of bringing the peg directly over the hole punched in the sole of the shoe by the withdrawn awl; the whole constructed and operating substantially as set forth. 6th, I claim the combination of cam *o*, and stirrup *m*, with the swung peg cutter, by which the peg wood is split with the grain of the wood from below, by the knife at 55, and at the same time forced in the tube in n; it being understood that I do not claim the general feature of a peg cutter forming one side of the tube through which the peg is driven, but only the particular mode of applying it, as here claimed."

55. For an *Improvement in the Oven Doors for Cooking Stoves and Ranges;* Gibson North, Philadelphia, Pennsylvania.

Claim.—"I do not claim the application of brick, or any other material which is retained in its place by lattice work, or some other similar contrivance; but what I claim is, the application of an adhesive coat of enamel, or other substance answering the same purpose, to the inside of the oven doors of ranges or cooking stoves, substantially as described."

56. For an *Improved Boat or Scow;* Abijah R. Tewksbury, Boston, Massachusetts.

Claim.—"I claim the above described improved method of constructing a boat, viz: by attaching its sides and ends to its bottom by water tight hinges, in combination with connecting the edges of the sides and ends by water tight flexible gores, substantially as described, and so that the boat may be unfolded on the sides, and ends be turned down into the plane of the bottom thereof, as hereinbefore explained."

57. For an *Improvement in Discharging Breech Loading Fire Arms;* Henry Stanton, U. S. Army.

"My invention relates to that class of fire arms and ordnance which is loaded at the breech instead of the muzzle, and consists in constructing a movable breech in such manner that it will, when placed in one position, form a prolongation of the bore to allow the load to be introduced through it into the chamber of the piece, and when placed in another position, will close the butt end of the bore, preparatory to firing off the charge; and, in addition to these, which are the ordinary duties of this class of breeches, this shall also perform the duty of a lock, in firing the charge."

Claim.—"What I claim is, the method herein described, of firing the charge of breech loading arms by the breech itself, in the act of closing, thereby dispensing with the ordinary lock, and greatly simplifying the construction of arms, and diminishing, correspondingly, their cost and liability to get out of order, and increasing their durability and efficiency. I also claim the method of igniting the charge by shearing through the fulminating compound attached to the cartridge, substantially as herein set forth."

AUGUST 23.

58. For *an Improvement in Processes for Purifying Alcohol;* Luther Atwood, Boston, Massachusetts.

"The nature of my invention consists in destroying, by chemical means, the fusel oil and odorous oils found present in alcohol and alcoholic spirits. I take of finely ground manganese oxide, 3 lbs., nitrate of potash, or nitrate of soda, 5 lbs., in a state of mixture, and slowly melt them in a crucible, continuing the heat until the melted mass passes from a fluid to a stiff pasty mass. When cold, the mass must be powdered and kept dry for future use. It contains manganate of potash or soda, or gives permanganates of these bases, with excess of potash or soda and earthy impurities. For every gallon of alcohol of 85 or 90 per cent., I use two ounces of the manganic compound, dissolved in 8 oz. of water, and add the solution to the alcohol while the whole is briskly agitated. This proportion is the average quantity required for common alcohol, but so much should be used

as is sufficient to destroy the odor of the fusel oil; and the purified alcohol must then be distilled from the matters dissolved and suspended in it by gentle heat."

Claim.—"What I claim is, the use of the manganates and permanganates, existing as soluble compounds, however obtained, for purifying alcohol, so as to adapt it to nice purposes."

59. For an *Improved Method of Generating Steam;* Jean Baptiste Moinier and Pierre Hippolite Boutigny, Paris, France; patented in France, January 18, 1853.

"The nature of our invention consists in so forming the generator as to cause a direct production of steam at high temperatures, (500 degrees and upwards,) by means of injecting water at the top, or near the top of the generator, when the same is in a heated state, and causing the water to come in small quantities in contact with the surfaces of perforated metallic diaphragms, (placed within the generator,) and also to come in contact with the sides of the generator, so as to increase the evaporating surface of the generator."

Claim.—"What we claim as our invention in generators for generating steam at high temperatures from water introduced into the generator, when in a highly heated state, is, injecting or introducing water from the top, or near the top of the generator, when this mode of feeding or introducing the water is combined with the series of perforated metallic diaphragms described, arranged one above another in the generator, so as to subdivide the water, and at the same time increase the evaporating surface of the generator, substantially as described, the water being gradually heated, and subdivided in its passage through the apertures or meshes of the diaphragms, before it comes in contact with the more highly heated surface of the generator, substantially as described."

60. For an *Improvement in Soap Cutting Machines;* James B Duff, City of N. York.

"The nature of my invention consists in the employment of a traversing slatted bed or carriage, having a hinged head piece or follower, in combination with a series of vertical and horizontal yielding wire cutters."

Claim.—"What I claim is, making the wire knives, arranged and set with weights, capable of yielding, so that they will form a loop in passing through the soap, and consequently cut it smooth and straight, in combination with the feeding slatted bed, or any other equivalent device for feeding and forcing the soap up to the said yielding wire knives, the whole being constructed and arranged, and operating essentially as herein described."

61. For an *Improvement in Oscillating Steam Engines;* Morris J. Gardner, York, Pa.

"The nature of my invention consists in the manner of introducing the steam through circular tubes into the steam chest, and at the same time constituting these tubes the circle around which the cylinder oscillates, in the manner substantially set forth."

Claim.—"What I claim is, the mode of introducing the steam; the circular steam tubes, the circular steam chest, and packing boxes, operating in the manner herein described. I do not, however, confine my claim to the precise position or dimensions of the various parts described in the foregoing specifications, but to use such positions and dimensions substantially the same, as may be best adapted to produce the desired effect."

62. For an *Improvement in Seed Planters;* Peter Horn, Hagerstown, Maryland.

"The nature of my invention consists in providing the boot with an arm, which is attached to the frame by a hinge, and is operated by a lever whose fulcrum is also attached to the frame, and by which the boot may be lowered or elevated at pleasure; also, in having the feed bar divided in the centre, and each operated by different powers."

Claim.—"What I claim is, the spring, in combination with the projection, and arm or lever, for the purpose of opening and closing the recess through which the seed passes, substantially as set forth. 2d, I claim the arm or lever, in combination with the lever and fulcrum, for the purpose of raising or lowering the drill tubes, and operating the springs, substantially as set forth and described."

63. For an *Improvement in Hay Rakes;* Frederick B. Parker, Queensville, Indiana.

"The object of my invention is, to provide an efficient preventive to the accidental tipping of the rake."

Claim.—"I claim as new, the spring catches, projecting downwards from the front ends of the hand bars, and provided with sloping lips, which, bearing upon the front tines, assist in holding the rake to its place until relieved by the withdrawal of the main stop, in the manner described."

64. For an *Improvement in the Arrangement of Cutters for Turning;* Milton Roberts, South Levant, Maine.

"This invention relates to an improved lathe attachment for turning bedstead posts, chair stuff, and the like, and consists in placing a series of knives or cutters and beading tools, one or both being used, in a suitable frame; said frame being moved in a direction transversely of the stick to be turned. The stick is centred in an ordinary lathe, and the frame, with its guides, are so attached to the lathe as to allow the knives to come in contact with the stick as the frame is moved; the knives operating upon the stick sufficiently to give it the required form during a single stroke or vibration of the frame."

Claim.—"Having thus described the nature and operation of my invention, what I claim is, arranging straight edged and grooved cutters on a frame moving parallel to the axis of the lathe, when said cutters are placed in pairs obliquely to the piece to be turned, each set forming salient angles with each other in the frame, by which arrangement each set acts by a gradual drawing cut upon the piece, the grooved tools following to finish the work."

65. For an *Improvement in Grate Bars;* Samuel Vansyckel, Little York, New Jersey.

"The nature of my invention consists in casting or otherwise securing to the under sides of grate bars, hooks or catches, through which series of hooks or catches a rod or bar is passed and held, and by which the grate bars are prevented from warping or twisting by the heat, or from falling down, if one end should slip off."

Claim.—"Having thus fully described the nature of my invention, what I claim is, forming a hook or catch upon the under side of the grate bars, and passing through or over said hooks or catches a holding bar to prevent twisting or warping, substantially as described."

66. For an *Improvement in Butter Workers;* Lettie A. Smith, Pineville, Pa.

"My invention consists, 1st, in combining with a butter tray or pan, a cooling drawer or reservoir, which is placed under it, and into which ice is placed for keeping the butter in a cool and nice state while being worked. 2d, In an adjustable apparatus for working the butter, one end of the handle of the same passing through a circular opening in the back of the stationary frame, and the other end extending over the front part of the tray."

Claim.—"What I claim is, 1st, the combination of the cooling drawer or ice box, with a butter tray, for the purpose described. I do not claim, in general, the device of the working lever, in combination with a butter tray or table; but I claim forming such working lever with acute angles at the sides of its working face, so that it may serve the double purpose of breaking or pressing the butter, and turning it over."

67. For an *Improvement in Railroad Car Seats;* William M. Warren, Watertown, Connecticut.

"My invention consists in the employment or use of sliding foot boards, constructed and arranged in a peculiar manner, so as to be used on either side of the seat, as occasion may require."

Claim.—"Having thus described my invention, what I claim is, the manner in which the foot boards are constructed and arranged, viz: the foot boards being attached by joints to slides, said slides having racks on their upper surfaces, and working on beds connected by hinges; the under sides of the slides being provided with spurs or clicks, which catch into the racks, and retain the foot boards when pressed upon by the feet; the beds being retained underneath the seat when the foot boards are not in use, by means of the catches, or by any other convenient mode."

68. For an *Improvement in Boring Cannon;* Louis A. B. Walbach, deceased, late of the United States Army.

"1st, My invention consists in producing a cylindrical hole in any solid substance suitable for making cannon or small arms, by boring out an annulus of the diameter of the required hole, leaving a central core, two-thirds, more or less, of the diameter of the bore, which can be broken off when the annulus is completed to the required depth, and removed in a solid mass, instead of being cut into fine chips or shavings, as in the ordinary way of boring, whereby much labor and time are saved, and the expense of boring is greatly reduced. 2d, The core likewise furnishes a sample or test of the nature or quality of the material in the interior of the substance being bored, and this method of sampling the material, which is highly important in the boring of cannon, constitutes another branch of my invention. 3d, The means of removing the core after the annulus is bored, consti-

tutes another branch of my invention." "This mode of boring cannon differs from all others now practised or known; 1st, In leaving a solid core formed by the cutting of an annular space around it while the boring progresses, and which core is usually of greater bulk than half of the material to be removed; and, 2d, In afterwards detaching this core as a solid, instead of reducing it to particles in the form of chips and dust, as in the usual mode of boring. The dead centre of the ordinary boring tools, which is a great impediment to the progress of the work, is entirely avoided by my method of circumaxial boring, wherein no such centre exists. The centre of every common boring bit forms its pivot or axis of revolution, and having little or no circumferential motion, cannot possibly cut out a chip. It can therefore only progress through the substance by the force of pressure or crushing alone. In my method, the cutting edge is reduced in extent to at least one-third of that of any other boring tool, by which both time and expense are saved, in proportion to the diminished amount of material to be removed; and being placed at and near the periphery of a hollow cylinder, it works there with greater effect in the ratio of its greater distance from the axis, and by avoiding the dead centre of other modes of boring, effects a still further saving of time, in proportion to the greater facility of cutting, over that of forcing or crushing a tool into the mass to be perforated."

Claim.—"What I claim is, the method herein described, of boring cannon, or the barrels of other ordnance or fire arms, by perforating the same with an annular hole, which leaves a central core, in combination with a second operation for detaching and removing the core, substantially as specified, whereby the amount of material to be reduced to chips, the time and labor of boring, and the wear of tools, are greatly diminished, and the accuracy of the work increased. I also claim the transverse cutter, or the equivalent thereof, for grooving or cutting off the base of the core, substantially as specified. I likewise claim the method herein described, of ascertaining the quality of the gun by taking out a core of sufficient diameter and length from the axis or centre of the bore, to be tested mechanically, or otherwise."

69. For an *Improvement in Counterpanes;* Zacharia Allen, Providence, Rhode Island.

"It has long been an acknowledged desideratum to produce a woven cotton counterpane, as ornamental and durable as the Marseilles quilt or counterpane, and at little or any greater price than a common calico sheet of the same size, weight, and quality of material, so that while it would be sufficiently neat and ornamental to adapt it to the tastes and use of the rich, its price will be so low as to bring it within the reach of all who can afford to maintain a bed. The object of my present invention is to supply this desideratum, and it consists in weaving cloth of a width equal to the length required for a counterpane, the weft of the cloth being composed of cord and thread woven in alternate order, the thread being the usual size for the warp employed, and the cord considerably thicker; the different wefts being so woven as to form a ribbed surface."

Claim.—"What I claim is, the ribbed counterpane herein described, as a new manufacture, it being so made that the thickness and twist of the cords forming the ribs on the same, by their tendency to untwist, will give to the said ribs a wavy or undulating surface, as herein set forth."

70. For an *Improved Padlock;* Henry Ritchie, Assignor to Samuel C. Thompson, Geo. W. Westerfield, and Henry Ritchie, Newark, New Jersey.

"This invention relates to a new and useful improvement in spring padlocks, and consists in the combination of a bolt, toothed tumbler, and guard, so arranged as to prevent the bolt from being forced from the shackle in the bow by means of blows, or by violently striking the case of the lock; the toothed tumbler also allowing the lower end of the bow, when pressed in the lock, to operate the guard, and thus allow the bolt, or its projection, to pass into the shackle."

Claim.—"Having thus described my invention, what I claim is, the combination of the bolt, guard, and the double toothed tumbler; one tooth of said tumbler fitting in the shackle, and the other tooth fitting in the notch at the back of the bolt; the bolt, guard, and tumbler, operating as set forth in the body of the specification."

71. For an *Improved Machine for Cutting and Beveling Printers' Rules;* Snow Magoun, Newton, Assignor to Emery N. Moore and Charles H. Crosby, Boston, Mass.

"Printers' rules, the strips of metal used by printers for ruling lines, have hitherto been cut off and beveled by a slow and tedious process by hand, the strips being usually cut off by a saw, and the edges afterwards mitred or beveled by filing. By my improved machine they can be finished with much greater speed and nicety than by hand, being cut off and beveled by a tool set in a sliding carriage, and operated as explained."

Claim.—"What I claim is, the machine herein above described, for cutting and beveling printers' rules, constructed with a sliding tool carriage, which carries the cutting tool forward and back across the rule, as above set forth."

72. For an *Improvement in Diving Bells;* Johnathan Foreman, Boston, Massachusetts, Administrator of Edgar W. Foreman, deceased, late of New Rochelle, New York, and Assignor to Henry W. Sears, City of New York.

"The nature of this invention consists in so combining with a reservoir of condensed or compressed air at the surface, and in connexion with the driving chamber, an arrangement of sliding blocks or movable pulleys attached to an anchor and the diving chamber, that motion and direction may be given to the diving chamber. The peculiarity of this invention is, that by the combination of a reservoir of condensed air at the surface, in communication with the diving chamber and the traversing block, it is practicable at all times so to regulate the equilibrium of internal and external pressure, and to control the movements of the bell. 1st, Exceedingly light and weak materials may be used in construction; 2d, That the specific gravity of the diving chamber, through the medium of the compressed air as a motor, may be instantaneously changed, and either ascent or descent may be attained solely at the will of the operator within said chamber. The condensed air acting instantaneously, causes an expulsion of a certain desired amount of water. A correspondent buoyancy is thus effected, which may be absorbed by a weight, say a stone to be transported to a certain designated spot. The power from the reservoir thus gives vertical movement to the machine and mass to be operated on, which upward motion may be checked at any moment by properly working the air and water valves. The mass thus held in suspension is now moved by the arrangement of anchors and cables passing over the movable pulleys, as described, the point of traction of the cables being regulated by the movable block. The desired spot being reached, by allowing the admission of water, the mass, or the machine itself, will descend to the bottom, but not occupy the precisely desired spot; by successive action of the air valve, vertical, and at the same time horizontal, movements may be effected until the machine or suspended mass occupies the indicated spot."

Claim.—"What is claimed is, the combination of the reservoir of compressed air at the surface, in connexion with the diving chamber or bell, and the arrangement of the movable block or pulley, as herein described, whereby the chamber or bell may be moved and directed at the will of the operator within, for the purpose above set forth."

73. For an (*additional*) *Improvement in Machines for Separating Straw from Grain;* Elisha S. Snyder, Charlestown, Virginia; Original Letters Patent dated June 13, 1848.

Claim.—"Having fully set forth, in addition to the original patented specification, the importance and utility of my said additional improvements, and having referred thereto by diagrams, explanations, and letters of indication, what I designate as new and original with myself, is as follows: 1st, I claim the pecular construction of the rotary apparatus, formed of concavo-convex aprons or shields, combined with the curved prongs, the said rotary apparatus used in combination with the threshing cylinder, specifically as set forth. 2d, I claim setting the spout at about an angle of 45 degrees with the horizon, and adding the escape pipe to prevent the grain from flying about."

AUGUST 30.

74. For an *Improvement in Hot Air Furnaces;* M. B. Dyott, Philadelphia, Penna.

"This invention relates to certain improvements in hot air furnaces, and consists in the combination of the inner cylinder or flue and the drum which encircles the fire chamber, arranged as described. By this arrangement, it will be seen that the cold air that passes into the space between the drums and fire chamber, keeps the fire chamber from being burnt; and the air itself is of course heated by the fire. The internal cylinder or flue also supplies a current of warm air, and a great heating surface is exposed. The heat from the fire chamber passing around the drums, is prevented from passing off, and communicates heat to the air within the shell."

Claim.—"I do not confine myself to any particular shape or form of air chamber or drums, whether conical, cylindrical, or otherwise; I do not claim separately, any of the devices or parts herein named; but what I do claim is, the combination of the internal cylinder or flue with the drums, arranged in the manner described, by which combination a great amount of heating surface is exposed."

75. For an *Improvement in Benzole Vapor Apparatus;* Oliver P. Drake, Boston, Mass.

"An apparatus made in the above mentioned manner, will not only be found very efficient in the production of benzole vapor mixed with air, but will produce such a regular pressure and flow of such æriform mixture through its gas burner or burners as will cause an unsurpassed steadiness in the height of the flame; besides, the luminosity of the flame is far greater than that of the coal gas."

Claim.—"I claim as my invention, the combination of the heater and gas burner, with the water vessel and vaporizing chamber, substantially as specified, so that by means of the said heater and gas burner, and the pipes connecting them with the water vessel and the chamber, the whole or part of the mixture of air and benzole vapor produced by the apparatus, may not only be used in any convenient place for the purpose of illumination, but also for heating the water of the vessel, as specified. I am aware that for the purposes of evaporating saccharine fluids, a hollow shaft, surrounded by plates and having perforations, has been made to revolve over an open cistern, (containing the saccharine liquor,) while air has been blown into such shaft, and made to pass against the plates partially immersed in the liquid and put in revolution; I therefore do not claim such. But what I do claim as my invention, and for the purpose of vaporizing benzole, or other suitable volatile hydro-carbon, and mixing it with air, is, the combination of the closed vaporizing chamber, the rotary vaporizer or disseminator, (placed therein,) and the rotary meter wheel and its closed case, or an air forcing apparatus, as made to force a stream of air into the hollow shaft of the vaporizer, and through or against the saturated portions of the disseminator, and into the vaporizing chamber and regenerator, so as to vaporize the benzole or hydro-carbon, and mix it with air, substantially as above specified. And in combination with the rotating meter wheel and its case, and the hot water vessel, I claim the coiled induction air pipe, as made to pass through the water in the vessel, and thereby receive heat therefrom, so as to warm the air as it passes through the pipe, and to supply oxygen to the volatilized vapor, and for the pupose of facilitating the evaporation of the same. And, in combination with the induction air pipe, I claim the chamber and its regulator slide and orifice, applied for the purpose of supplying cold air to the warmed air, or to the meter wheel, in order to diminish or regulate the temperature of the air passing into the said wheel, and forced into the vaporizing chamber. I also claim the peculiar mode of making the rotary disseminator or vaporizer, viz: of two perforated heads or disks, a hollow perforated shaft, and strands of lamp wicking, or other absorbent material, stretched from one head to the other, as specified. And for the purpose of an air blast apparatus, I claim the application and use of the meter wheel, its closed case and liquid therein, substantially in the manner as above specified, not meaning to claim the method of using the meter for the admeasurement of gas, and wherein the wheel of the meter is turned by the gas itself, but meaning to claim it as having its wheel operated by a separate power, and applied in conjunction with the water and closed case, and induction and eduction pipes, for the purpose of blowing air, as specified."

76. For an *Improvement in Stove Pipe Collar;* R. R. Finch, Jr., City of New York.

"The nature of my invention consists in having a collar attached to the end of the flue, which projects a short distance from the stove; one side of the collar as well as the end of the flue being beveled at an angle of 45°, by which arrangement the collar may be so placed or attached to the end of the flue, that the pipe may project horizontally from the stove, or perpendicularly from it, as desired; said collar being movable or reversible, and fitted to the flue by means of a flanch and button on the end of said flue. By this simple device, a vertical or horizontal smoke pipe may be attached to a stove without any inconvenience. In summer, when the least possible heat is desired in a room from a cooking stove, the pipe may be made to run horizontally with the chimney, leaving but a small heating surface of pipe in the room; but in winter, when heat is indispensable, by merely reversing the position of the collar, the pipe may be run vertically into a chamber above, or into the chimney at some distance above the fire place. The reversible collar also saves the expense of an elbow at the end of the flue, when the direction of the smoke pipe is changed."

Claim.—"Having thus described my invention, what I claim is, the reversible collar, constructed, arranged, and applied to a stove, in the manner and for the purpose substantially as shown and described in the body of the specification."

77. For an *Improvement in Stoves;* Thomas S. Gore, Jersey City, New Jersey.

"The nature of my invention consists in surrounding an inner cylinder or chamber of the stove with spiral flues, so arranged or connected to the base, that the heat which passes

down the spiral flues will meet or unite with a main flue or pipe connected to the ordinary smoke pipe. The arrangement of the spiral flues and base, by which a large heating surface is obtained, as will be hereafter shown, constitutes the invention."

Claim.—"Having thus described my invention, what I claim is, the spiral flues surrounding the cylinder, arranged and connected to the base, substantially as shown and described, for the purpose of obtaining a large extent of heating surface for the flues, and also for forming a space between them for the admission and heating of cold air, as set forth."

78. For an *Improvement in Conductors in Machines for Forming Hat Bodies;* Lansing E. Hopkins, City of New York.

"My improvement in forming hat bodies consists in a bifurcated conductor, so constructed and arranged as to place the exhaust cone between two jets of fur."

Claim.—"Having thus fully described my improvement in hat forming machinery, what I claim is, the bifurcated conductor and blast above described, said conductor having its openings opposite each other, or nearly so, and having the cone between them, substantially in the manner and for the purposes set forth."

79. For an *Improvement in Steam Boilers;* Benjamin Irving, Green Point, New York; patented in France, May 12, 1853.

"The improvements which are comprehended in this invention have in view, chiefly, to secure a more perfect combustion of the gases generated by the consumption of fuel, and to present a large extent of heating surface without subjecting any part of it, when working properly, to a very intense heat; to guard against explosions of the boiler; to gain more compactness and strength in structure, and to diminish the necessary weight of metal and quantity of water. The results claimed for these improvements are, economy in amount of fuel and in expense of construction, safety from explosions, increased strength and durability, and adaptedness for the use of coal or wood to propel engines on railroads, and for all other purposes."

Claim.—"What I claim is, 1st, A boiler composed of an external water-jacket, of cylindrical or other form, with a steam chamber at the top, and with or without one or more inner water jackets connected with the outer water jackets, substantially as described, when either water jacket contains one or more vertical coils of steam pipe, whose lower ends connect with one of the water jackets, and whose upper ends discharge into the steam chamber, substantially as set forth. 2d, Drying the steam by passing it through a coil within or between the water jackets, substantially as set forth."

80. For an *Improvement in Cider Mills;* John Krauser, Reading Pennsylvania.

Claim.—"I do not claim as of my invention, the employment of two or more pistons or plungers, in combination with the grinding cylinder, nor operating them by the machine itself, whether the motion derived therefrom be uniform or not; but what I do claim is, in the first place, so arranging the hopper with reference to the several operating parts of the machine, that the fruit or other substance contained therein, shall not rest directly upon or against the roughened exterior of the grinding cylinder, but directly upon so much of the upper surface of the anterior ends of the pistons or plungers as shall be found operating or exposed within its enclosed sides, for the purpose of agitating the incumbent substance, so as to insure and facilitate the filling of the cells, as the pistons recede from the cylinder. And, in the second place, which is a consequence of the first, viz., to cause the incumbent substance to press upon the cumbent, or that contained within the cells, so as to oppose the upheaving or ejectment of the same whilst in the act of being pressed against the passing teeth of the revolving cylinder by the action of the alternating pistons or plungers, as herein more fully described and set forth."

81. For an *Improvement in Hemp and Flax Breaking Machines;* O. S. Leavitt, Maysville, Kentucky.

Claim.—"Having described the construction and operation of my invention, I do not wish to be understood as limiting myself to the precise construction and arrangement of parts herein specified, as I have only described the mode of application which I have essayed with success. What I claim is, the combing apparatus as described, in connexion with the pieces which move alternately up and down, to hold the hemp or flax against the action of the combs."

82. For an *Improvement in a Machine for Distributing and Composing Type;* Wm. H. Mitchel, Brooklyn, New York.

"The nature of my invention consists in means for distributing the types from the forms,

and setting them up in rows within grooves, a given letter in each row, with the faces of the types upwards, and the bottoms of the types in a line; from which grooves the types are removed, each row of a given letter at a time, and placed within slides or conductors which supply them to an apparatus connected with the finger keys. The striking of any given finger key drops one of the corresponding types on one of a series of belts, which are moved by competent pulleys. This series of belts is elongated as the latter approach the delivery end of the machine, and is combined with a diagonal belt, so that any given type dropped on any one belt, takes an equal time to reach the point of delivery, that is, the composing apparatus, and consequently the types, reach that point in the same order in which they are dropped by the finger keys. This is effected by the diagonal belt aforesaid, to which the types are transferred from the series of belts by means of small shoots, this diagonal belt carrying all the types to one point of delivery, where, by means of a conductor and composing wheel, they are set up in a line ready to be placed in the galley in lines of the required length, for transfer to the composing stone."

Claim.—"I do not claim arranging the composing apparatus so that each type has to travel nearly the same distance to the point of delivery from the point at which it is dropped, as this has been effected by grooves; but I am not aware of any apparatus in which a combination of belts has been arranged with a view to all the types taking an equal time to travel from the point of deposition to the point of delivery, thereby carrying the types with certainty, and avoiding all liability to stick or get into disorder. I do not limit myself to the precise arrangement of the belts, as long as the same end is attained; neither do I limit myself to the number or size of the parts, as these must be varied to suit the types, and the capacity required; but what I claim is, 1st, The feeding belt or belts, combined with the inclined plane, wheels, and grooves, to distribute the type in the manner specified. 2d, The mode herein shown for forming the distributing stick, with the points, spring, lips, and keys, so as to drop one type at a time on its side, as specified. 3d, The bridge and form of groove to separate the thick from the thin types as they slide down the incline, as specified. 4th, A series of belts of length increasing towards the point of delivery of the types, in combination with a diagonal belt to receive and convey the said types from the series of belts to the composing table or other point, in the order in which the types are dropped on the series of belts, as specified. 5th, Fitting the key for dropping the types so that it shall give a partial rotary motion to the shaft, to operate on the fork, or any analogous device to drop the types. 6th, The fork and blocking piece or stopper, to drop one type at a time when moved by the key, or any similar means, as specified. 7th, The composing wheel, to receive and set up the types, either in the composing or distributing apparatus, as specified, and I claim the combination of the said wheel with the fingers on the wheel, or with the bar, to supply said wheels, as specified."

83. For an *Improvement in Grain Harvesters;* Frederick Nishwitz, Williamsburgh, New York.

"This invention relates to certain improvements in reaping or harvesting machines, and consists, 1st, In a pecular construction and arrangement of cutters and fingers, which will be hereafter described. 2d, In the employment or use of flanched rollers, arranged as will be hereafter shown, for the purpose of throwing or detaching the grass or grain from the discharging ends of the belts."

Claim.—"Having thus described the nature and operation of my invention, what I claim is, 1st, The combination of the fingers and cutters, or their equivalents, constructed, arranged, and operating in the manner and for the purpose substantially as herein shown and described. 2d, I claim the employment or use of the flanched pulleys, arranged as shown, for the purpose of throwing or detaching the grass or grain from the belts."

84. For an *Improved Apparatus for Grinding and Shaping Metals;* Samuel Darling, Bangor, Maine.

Claim.—"What I claim is, the combination of the holder of the article to be ground with a grindstone or grinding disk, substantially in the manner herein set forth, so that the article and the stone will change positions relatively to each other during the operation in three directions, namely, towards each other, and parallel with, and transverse to the axis of the stone."

85. For an *Improvement in Saw Mills;* Andrew Ralston, West Middletown, Penna.

Claim.—"Having fully described my improved saw mill, what I claim is, 1st, Sawing logs or other descriptions of timber into lumber by means of a reciprocating saw operated in a horizontal position, substantially as set forth. 2d, I claim such an arrangement and

combination of the horizontal saw with the other parts of the saw mill, that the saw will run through and beyond each end of the log, or other description of material operated upon, and whilst in that position, will be automatically let down a distance equal to the thickness of stuff desired to be cut, and the motion of the carriage reversed to bring the saw again into action without stopping the machine, and so on until the log or other material operated upon shall be entirely sawn into the dimensions required, substantially as herein set forth. 3d, I claim connecting the operating pitman with the saw gate, through the medium of a secondary pitman, connected with the saw frame and saw gate, substantially as described, so that the operating force shall be applied in a direction nearly coincident with that of the saw in successive positions, for the purposes set forth."

86. For an *Improved Machine for Cutting Sheet Metal;* Stephen P. Ruggles, Boston, Massachusetts.

"The nature of my invention consists in so hanging the shear or separating blades, as that their cutting edges shall be in the same line, and one so placed above the other as not even to come in contact, much less overlap each other, by which means, I can cut a perfectly straight, square, and smooth edge, without the least warping or twisting of them, and with great diminution of power, from the fact that the cutting edges need not pass into the sheet or plate more than from one-half to two-thirds of its thickness, and yet it shall be entirely separated, and with smooth edges; and also, in hanging the cutting blades, or stocks on which they are supported, upon eccentric pins or bolts, for the purpose of giving them the most accurate adjustment which they require with the varied thickness of metal sheets to be cut."

Claim.—"Having thus fully described the nature of my invention, what I claim is, the so hanging of a traversing and a fixed cutting blade, one or both, as that their cutting edges shall not overlap, or come in contact with each other, by which means I am enabled to divide sheets of metal without twisting or warping their edges, and at great saving of power, substantially as described. I also claim the connecting of the upper and lower portions of the frame, when each carries one of the cutters, on eccentric bolts, suitably provided with screw and nut, or their equivalent, for giving the blades on the said two parts of the frame a perfect adjustment, one above the other, substantially as described."

87. For an *Improvement in Paper Files;* Daniel Winslow, Westbrook, and Perley D. Cummings, Portland, Maine.

Claim.—"We do not claim a file or bill holder as made of two plates of wood or pasteboard, or metal, held together upon the file of papers by one or more elastic bands; but what we do claim is, the combination of the plates with the elastic bands, so arranged that the side edges of the top plate shall be bent down upon the bands, and hold them securely, while the side edges of the bottom plate are turned, but left far enough from the bottom plate for the bands to move freely between them and the said plate; the edge lips of both plates being bent inwards and rounded on the corners, as to protect the bands from being chafed or worn, as described."

88. For an *Improvement in Machines for Splitting Leather;* Charles Weston, Salem, Massachusetts.

"My improvement consists in an arrangement for adjusting and holding the spring plate in a novel manner, by attaching the arm which operates the cams to a spring rack, so that the spring plate will not only be susceptible of adjustment for the different thicknesses of the split, and exert a constant and uniform pressure upon the same, but will also yield to the various inequalities of the hide as it is drawn through the machine."

Claim.—"Having thus described my improvements, what I claim is, the arrangement herein above described, for exerting a constant and uniform pressure upon the leather, and at the same time allowing the spring plate to yield to the inequalities of the hide, the same consisting in a spring rack for holding the arm which is connected to the spring plate by the turning shaft and cams, as above set forth."

89. For an *Improvement in Apparatus for Purifying Gas;* William Wigston, City of New York.

"The nature of the invention consists in what I term a scrubber, which is a float of wood or other material, of circular or other form, of sufficient buoyancy to float in the purifying liquor, with an interior cavity above the surface of the liquor, and with passages leading from the said cavity through its sides, and the gas enters through the inlet pipe which rises through the liquor, and opens into the cavity above its surface, escaping through the passages through the sides. These passages are so arranged that they are

almost or entirely submerged, when there is no pressure of gas; but that when there is a pressure, the float will be raised so as to bring a small portion above the surface, to allow the escape of the gas in very thin streams, and thereby bring every portion of it in contact with the liquor."

Claim.—"What I claim is, constructing the scrubber or float with a cavity, to receive the gas above the surface of the fluid, and partly submerged passages leading from the said cavity through the sides of the float to allow the escape of the gas from the cavity, and cause its distribution over the surface of the fluid in thin streams, to produce a diffused contact with the fluid, as described."

90. For an *Improvement in Machinery for Cutting and Bending Metallic Disks;* Elliot Savage, Assignor to Franklin Roys and Edward Wilcox, Berlin, Connecticut.

Claim.—"What I claim as my invention is, the combination and arrangement of the roller with the roller and the bending roller, so as to operate together, and independently of the clamps, substantially as specified."

91. For an *Improvement in Shingle Machines;* Elijah Valentine, Palmer, Assignor to Abel Bradway, Monson, Massachusetts.

Claim.—"What I claim is, the series of rollers placed above the platform, when they are combined with the ledges which rise from the sides of that portion of the platform that receives the riven shingles to be operated upon, and so arranged that when a rived shingle is first carried forwards, the said rollers will be elevated above its upper surface by the said ledges, and when the driver is drawn back, it will at the same time pass from under the said shingle, and from under the rollers, thereby allowing the shingle to fall upon the platform, and the rollers to fall in succession upon the upper surface of the shingle, for the purpose of giving to the said shingle such a shape and position upon the platform, that it will be carried onwards again by the next forward movement of the driver, and be operated upon by the dressing knives, substantially as herein set forth."

Designs for August, 1853.

1. For a *Cooking Stove;* Julius Holzer, Assignor to North, Chase & North, Philadelphia, Pennsylvania, August 2.

Claim.—"The design and configuration of the mouldings described, forming an ornamental design for a cooking stove."

2. For a *Sewing Bird;* Allen Gerould and John H. Ward, Middletown, Conn., Aug. 2.

Claim.—"The design of an entire bird in a sitting posture, constituting an ornamental design for a sewing bird."

3. For a *Statue of Daniel Webster;* Thos. Ball, Assignor to Geo. W. Nichols, Boston, Massachusetts, August 9.

Claim.—"I claim the new design for a statuette of Daniel Webster, as described and represented in the drawings."

4. For a *Cooking Stove;* John W. Van Cleve, Assignor to James Greer & Co., Dayton, Ohio, August 16.

Claim.—"I claim the design and configuration of the ornaments for a cooking stove, described and shown in the drawings."

5. For a *Stove;* Samuel H. Sailor, Assignor to J. G. Abbott and Archilus Lawrence, Philadelphia, Pennsylvania, August 23.

Claim.—"I claim the configuration and arrangement of the ornaments in bas-relief, and mouldings on the plates and door, as set forth in the specification and drawings."

6. For a *Milk Stool Frame;* P. A. Palmer, Leroy, New York, August 30.

Claim.—"I claim the ornamental design and configuration, such as described and represented."

7. For a *Cook Stove;* Frederick Schultz, County of Philadelphia, Assignor to Charles and Samuel Gilbert, Philadelphia, Pennsylvania, August 30.

Claim.—"The configuration and arrangement of the ornaments in bas relief, and mouldings on the plates and doors, oven door, and foot, as described in the specification and drawings."

8. For a *Parlor Stove;* Garrettson Smith and Henry Brown, Assignors to J. G. Abbott, and Archilus Lawrence, Philadelphia, Pennsylvania, August 30.

Claim.—"The configuration and arrangement of the mouldings and ornaments on the front, top, and base of the stove, together with the form and configuration of ornaments on the front and urn, as set forth in the specification and drawings."

SEPTEMBER 6.

1. For an *Improvement in Straw Cutters;* James T. Asbury, Taylorsville, N. Carolina.

Claim.—"What I claim is, the combination of the three cutting knives, as described, with the recessed arms, whereby one-third of the feed of straw is cut successively by each knife, the protruding uncut portion passing through the recesses in the arms during the operation, substantially as specified."

2. For an *Improvement in Nut Crackers;* Philos Blake, Eli W. Blake, and John A. Blake, New Haven, Connecticut; ante-dated March 6, 1853.

"Our improvement consists in a peculiar arrangement of the jaws, in relation to each other, and to the axis on which the movable jaw turns; and in combining therewith stops to limit the motions of the movable jaw in both directions. Such is the joint effect of these modifications, that without any attention or caution on the part of the operator, our instrument will subject every nut to the proper amount of compression and no more, however the nuts may vary in size or hardness."

Claim.—"Having thus described our improved nut cracker, and the manner of using it, we would now state that we do not claim the use of jaws, forced together by a lever, to crack nuts, since that device is found in the common nut cracker; nor do we claim the mere divergence of the jaws, irrespective of their position, in relation to the axis of motion, since the jaws of the common nut cracker diverge when opened to receive a nut; but the jaws of the common nut cracker diverge in a plane which is at right angles to the axis of motion, and, consequently, nuts of different sizes are received between them at different distances from that axis; whereas, the jaws of our instrument diverge in a plane which is parallel to the axis of motion, and, consequently, nuts of different sizes are received between them at the same uniform distance from the axis of motion, which condition, or a near approximation thereto, is indispensable to the cracking of nuts of different sizes, between jaws whose motions are limited by stops in both directions, as described. What we do claim is, 1st, The divergence of the jaws in a plane which is parallel to the axis of motion, as herein described and shown in the drawings, whereby nuts of different sizes are all received at a uniform distance from the centre of motion. 2d, The divergence of the jaws in a plane parallel to the axis of motion, in combination with the two stops collectively, which limit the motions of the movable jaw, as herein described. 3d, The divergence of the jaws in a plane parallel to the axis of motion, in combination with their extension beyond the supports of the axis, as described and shown in the drawings, whereby the line of the axis of motion is brought in close proximity to the acting faces of the jaws, without impairing free access to them, to introduce and remove the nuts. In conclusion, we add, that in the foregoing claims we do not intend to confine ourselves to a strict parallelism between the plane of the jaws and the axis of motion, since it is obvious that some variation therefrom would not defeat the object aimed at, by approximating to parallelism, in distinction from placing the plane of the jaws at right angles to the axis of motion, as in the common nut cracker. Indeed, we have contemplated as a possible improvement, the placing the outer ends of the jaws a little further from the axis of motion than the other end, with a view to have them act on large nuts through a space somewhat greater than on small ones.

3. For an *Improvement in Machines for Edging Leather Straps;* James Barnes, Franklin, New York.

"The nature of my invention consists in constructing a machine, so that by drawing through it strips of leather of different width, they are all rounded to the same curve, so as to give uniformity to the swelling of different parts of a harness, with one knife, and without the change of any part of the machine, a single movement adjusting the gauge to any width desired."

Claim.—"What I claim is, the combination of the parallelogram and inverted dividers, as a regulating gauge, to work in front of the edge of a curved knife, so that strips of eather of different widths may be rounded to feather edges with the same perfection,

without the change of knife, or any part of the machine; the whole being constructed substantially in the manner herein described."

4. For an *Improvement in Printing Presses;* Victor Beaumont, City of New York.

Claim.—"I do not claim a type cylinder, or any particular mode of holding the type in place, or the using any portion of the periphery of the type cylinder for a distributing surface; but what I do claim is, 1st, The combination of two or more impression cylinders with a type cylinder, so arranged as to print all over on one side a continuous sheet of paper, in the manner described. 2d, The combination of the eccentric rod and the folder, so arranged as to lay the continuous sheet in piles after being printed on one side, as described. 3d, The combination of the indented knife with the roller, so arranged as to cut the sheet into proper length, as printed."

5. For an *Improvement in Piano Fortes;* Wm. Compton, City of New York.

Claim.—"What I claim is, the means herein described and shown, for securing the strings into the angles of the T's by the combined operation of the up-bearing bridge or rest to which the T's are connected, and crossing and drawing the strings together at said bridge or rest, for the purpose of relieving the sounding board or rest plank of vertical pressure, as specified."

6. For an *Improvement in Sealing Preserve Canisters;* Henry Hunt, Brooklyn, New York.

Claim.—"What I claim is, excluding air from articles put up in closed canisters or other vessels, by providing the canister or other vessel with a metallic tube, or its equivalent, attached thereto, and after the air has been exhausted through the said tube, pressing it together air tight, that it may be soldered or cemented, to render the joint permanently air tight, substantially as described."

7. For an *Improvement in Horse Collars;* Joseph R. Lindner, City of New York.

Claim.—"I claim the union of the hame plate and collar, in combination with the lock plates, substantially as set forth. I also claim the triple fastening of the lock plates, in combination with the outward and backward spring of the hame plates, substantially as set forth."

8. For an *Improvement in Straw Cutters;* John Moyle, Martinsburgh, Virginia.

Claim.—"What I claim is, the combination of the rake and holder, constructed and operating substantially as described, for feeding the straw to be cut, and binding it to the box, as specified."

9. For an *Improvement in Printing Presses;* Chas. Montague, Pittsfield, Massachusetts.

Claim.—"Having fully described my improvement in printing presses, what I claim is, such a combination and arrangement of the cylinder and bed, that whilst one sheet is receiving its impression, the sheet to receive the next impression will be carried forwards upon the cylinder nearly to the bed, for the purpose of being in readiness to commence receiving its impression the moment after the bed starts upon its next forward movement, substantially as set forth."

10. For an *Improvement in Printing Presses;* Charles Montague, Pittsfield, Mass.

Claim.—"Having fully described my improved printing press, for printing on a continuous sheet, what I claim is, the combination of the intermittently winding cylinder and feed roller, or their equivalents, with the reciprocating pressure cylinder, bed, and rollers, arranged and operating in such a manner as to successively make an impression on the continuous sheet at each movement of the bed, substantially as herein set forth. In combination with a double set of inking rollers, I also claim the arrangement of the arms for inking both sets of rollers from a fountain placed vertically below the impression cylinder, substantially as described."

11. For an *Improvement in Feed Apparatus to Gas Generators;* Stephen Meredith, Erie, Pennsylvania.

"The nature of my invention consists in the construction of a peculiar retort, by which a heated surface is constantly presented to the tar fluid. This is effected by placing within the retort a revolving cylinder, upon which the fluid drops from a perforated pipe."

Claim.—"Having thus described my invention, what I claim is, the peculiar construction of the retort, as described, viz: having the retort of the cylindrical shape, or of other suitable shape, and placing within it a revolving cylinder, which, as it rotates, constantly

presents a heated surface to the fluid, and converts it into gas, preventing the fluid from cooling the retort, and also preventing the formation of any incrustation on the same, as set forth."

12. For an *Improvement in Bottle Fastenings;* James Spratt, Cincinnati, Ohio.

Claim.—"What I claim is, the application of the cup or cavity and aperture for sealing preserved edible substances, as set forth."

13. For an *Improvement in Machinery for Planing Metals;* Wm. W. Spafford, Boston, Massachusetts.

Claim.—"What I claim is, the combination of the receiving table or plate and its arm, (composing the radial arm,) the adjustable centre pins, or their equivalents, and the brace, together with the main planing table and its supporting frame, the same being made to operate substantially as specified, and for the purpose of adapting the planing machine to planing in curved lines, essentially as herein before set forth."

14. For an *Improvement in Counterfeit Coin Detectors;* Gideon B. Smith, Baltimore, Maryland.

Claim.—"What I claim is, a gauge or hole just large enough to permit the genuine coin to pass through, arranged in combination with a lever, acting below said gauge, balanced, so that the weight of such coin will depress it, so as to let said coin slip down through said gauge, which is too small to allow any spurious coin to pass, which is larger than the genuine; the lever being so balanced that any coin lighter than the genuine will not be heavy enough to depress it; so that all spurious coin, whether too large or too light, will stop in the gauge, while the genuine will slip through and fall out below, substantially as described."

15. For an *Improvement in Cotton Gins;* Henry L. Weeks, Hannahatchie, Georgia.

Claim.—"What I claim is, 1st, arranging and securing the boxes, in which the ginning rollers operate, in a revolving or adjustable frame or box, or its equivalent, so that the rollers can be adjusted or set at such an angle as may be requisite or desirable, as the condition of the cotton or other circumstances may require, so as to discharge the seed, or facilitate its falling from the rollers, after the cotton is drawn off by the rollers. 2d, Giving to the feeding aprons, or equivalent feeding devices, different velocities, for the purpose of spreading, distributing, or drawing apart the bolls of cotton, so that sand and dirt may fall out, and not be carried to the ginning rollers. 3d, Passing the cotton, after it is ginned, between double aprons, or equivalent devices, when said apron or devices move with less velocity than the ginning rollers, for the purpose of compressing and making more compact the cotton after it is ginned."

16. For an *Improved Process for making Twisted Gun Barrels;* Thomas Warner, Chicopee, Mass.

Claim.—"What I claim is, 1st, a new manufacture of gun barrels, made out of a solid bar, with the fibres of the metal having a gradually increased twist from the inside to the outside, substantially as specified. And in the process, I claim making twisted barrels by twisting a bar of metal of the required size, when in a heated state, and then boring out the calibre, substantially in the manner and for the purpose specified."

17. For an *Improved Paddle Wheel;* Benjamin Irving, Green Point, New York.

Claim.—"What I claim is, arranging and combining the floats, so as to form a series of buckets, of rhombic or substantially similar form, as and for the purpose herein set forth."

18. For an *Improvement in Straw Cutters;* Thomas Allison, Milton, New York.

Claim.—"I do not claim cutting straw in an oblique direction by means of spiral knives, set obliquely round the periphery of a cylinder, which has its axis set parallel with the axis of the feed trough, and which operate in combination with a parallel roller; but what I claim is, the construction and arrangement of the adjustable feed roller, which is made gradually tapering from its ends to its centre or middle, in the line of a curve, and arranged at an angle to the axis of the feed trough, and made to operate in combination with the cylinder of straight knives, and thereby facilitate the operation of the machine, as herein fully set forth and described; this arrangement rendering the machine less expensive, and more easy to be managed and kept in order."

19. For an *Improvement in Corn Shellers;* Levis H. Davis, Kennett Square, Pa.

Claim.—"What I claim is, the introduction of the wheels and arms, attached to the springs and regulated by the screws, as described, for the purpose of stripping the ear of the kernels, in the manner specified. I also claim the flanches upon the gear covering, for protecting the gearing from the admission of shelled corn, as herein fully set forth."

20. For an *Improvement in Corn Shellers;* Peter Dickinson, Amherst, Mass.

Claim.—"Having described my invention, what I claim is, the combination of the revolving spring shellers with the toothed rollers, operating in manner substantially as described."

21. For an *Improvement in Iron Car Brakes;* Stephen Morse, Springfield, Mass.

Claim.—"Having fully described my improved arrangement for brakes for cars, or wherever it may be suitably applied, what I claim is, the spine, having the point of suspension and socket, with the open spaces and brace plates, in combination with the rubber, or friction surface plate, substantially in the manner and for the purpose as is herein set forth."

22. For an *Improvement in Brick Machines;* Hiram Sands, Cambridge, Massachusetts, and Gary Cummings, West Derby, Vermont.

Claim.—"We do not claim the mode of operating the mould carriage by means of a crank, acting upon bars running across or attached to the mould carriage, as that has been employed before, in the brick machine of James Dane, patented Oct. 24, 1848; nor do we claim the mode of operating the pressing piston by means of a lever, actuated by revolving cams and connecting rod; nor do we claim the arrangement thereof with the cam shaft, made to pass beneath the pug mill, and these operate the mould carriage by means of a reversing gear applied to said shaft, as the like arrangement is contained in the patent of Dane, Healy & Cummings, August 5, 1851, ante-dated January 17, 1851; but what we do claim is, the modification of such arrangement, by substituting for the shaft with reversing gear, the shaft with continuous motion, operating the carriage and producing the intervals of rest by means of the crank pin acting alternately upon the studs connected with the mould carriage, whereby we obtain greater certainty and precision of action in the machine, with greater simplicity and durability. Also, in combination with the piston and the lever, we claim the slot in the lever, the slotted bearings, and the movable fulcrum pin, the connecting fork and hand lever; the same being for the purpose of increasing or diminishing the amount of pressure of the piston on the clay in the mould, as specified."

23. For an *Improvement in Printers' Ink;* Samuel H. Turner, of Brooklyn, N. York.

Claim.—"What I claim is, the employment of colophonic tar, produced and combined substantially as herein stated, both in the manufacture of printing ink, and also as a varnish used by printers to modify the condition of their ink to suit the temperature of the weather, and the kind of work to be executed, all as herein specified."

MECHANICS, PHYSICS, AND CHEMISTRY.

On the Manufacture of Cast Steel. By Dr. KARSTEN.*

Chemistry had already been established upon a scientific basis by the adoption of the doctrine of definite proportions at the time when attention was again directed to the compounds of iron with carbon. With regard to these substances, so important in the arts, the law of definite combining proportions did not appear to hold good; but the per centage of carbon was greater in proportion as the carboniferous iron approximated more closely to steel, and from this to cast iron. However, there still remained a possibility of reconciling the fact with the law, by assuming

* From the London Chemical Gazette, No. 256.

the existence of a definite carburet of iron capable of combining with iron in definite or indefinite proportions, and determining its characters. Still the existence of such a carburet of iron has never yet been proved. In the course of a former investigation of this subject, I was of opinion that I had really obtained such a substance. But the evidence of subsequent experience is entirely the other way; and even if such a compound were discovered, the difficulty would not be removed, for it would still be necessary to admit that it combined in indefinite proportions with iron. It would appear as if the combination of iron with carbon in indefinite proportions does not exceed a certain limit, and that the maximum per centage of carbon is about 5·93.

The classification of the various kinds of carburetted iron, under the general names of cast iron, steel, and bar iron, is entirely arbitrary, and based upon the physical characters. When entirely free from carbon, iron is so soft that it offers but little resistance to friction, and would be inapplicable to most of the purposes for which iron with more or less of carbon is employed. By combination with carbon within certain limits, it acquires greater hardness; the elasticity and ductility are increased. The increased hardness is especially remarkable when the strongly-heated metal is suddenly cooled. This character of some carburetted iron has been made the distinction between bar iron and steel, inasmuch as all bar iron which becomes harder when suddenly cooled is by universal consent termed steel. The analyses of a great number of varieties of iron has led to the result that the per centage of carbon may rise to 0·2, or even 0·25, before the metal has become considerably harder when suddenly cooled. The purer the iron is, the greater its freedom from adventitious substances, especially sulphur, silicium, and phosphorus, the larger may be the per centage of carbon requisite to determine its hardening when cooled suddenly. The best kinds of Swedish bar iron, and that made in Germany from spathic iron and brown iron ores, do not become very hard even when containing as much as 0·35 per cent. of carbon, although the hardness is such as to justify the appellation of steel-like iron. The transition from this kind of iron to true steel is so imperceptible, that it is necessary to adopt some arbitrary means of deciding whether the metal is bar iron or steel. If the carburetted iron acquires on sudden cooling such a degree of hardness as to give sparks when struck upon flint, it may be regarded as steel; and this degree of hardness requires a per centage of carbon amounting for the less pure kinds of iron to 0·5, and for the nearly pure iron to 0·65. However, steel containing such a small per centage of carbon is always but soft steel, which, to become capable of acquiring greater hardness, must be more highly carburetted. The hardness acquired upon sudden cooling increases as the per centage of carbon increases, but not in the same proportion. For iron almost perfectly free from adventitious substances, a per centage of 1·4 or 1·5 carbon corresponds with the highest capability of acquiring hardness and tenacity. With a still higher per centage of carbon, the steel acquires greater hardness; but its tenacity is lessened and the malleability decreases so rapidly with the increase of carbon, that with a per centage of 1·75 it can scarcely be welded at all. When the per centage of carbon amounts to 1·8, it is only with great difficulty that it can be forged, although with

a very great degree of hardness it may still possess considerable tenacity. Steel which contains 1·9 per cent. and more of carbon can scarcely be forged at all, and with a per centage of 2·0 the limit between steel and pig iron appears to be reached; for such metal in the soft state, that is, before being hardened, cannot be beaten out while hot without splitting and breaking under the hammer.

Steel, in virtue of the remarkable capability which it possesses, after cooling slowly from a high temperature, of being worked like soft iron, and then acquiring a considerable increase of hardness, without loss of tenacity on subsequent sudden cooling, has become a very valuable substance for various branches of industry. However, it has not yet been possible to refer the altered condition of hardness presented by the slowly and suddenly cooled metal to any altered state of combination of the carbon and iron in steel. Such wide differences of hardness and softness as those presented by steel which has been submitted to these two modes of treatment, can only be regarded as resulting from a total alteration of its molecular structure. The conjecture that the state of combination of the iron and carbon in hardened and soft steel respectively must be very different, is rendered in a high degree probable from the circumstance that such a difference in the state of combination of the iron and carbon in the carburets with a larger per centage of carbon—the different kinds of pig iron—may be proved to exist with perfect certainty. A distinction has always been made between white and gray pig iron. These substances differ so obviously in their characters—color, hardness, tenacity, and brittleness—that the fact could scarcely have been overlooked. In addition to this, the difference in their conditions of fusion must not be overlooked, the gray kind requiring a much higher temperature than the white iron, and passing almost suddenly from a solid to a liquid state, while the white iron not only fuses at a lower temperature, but before liquefaction becomes soft, and then pasty. Before a trustworthy method of separating carbon from iron had been discovered, it was supposed that this difference in the behavior of white and gray kinds of iron was attributable to the per centage of carbon, for on dissolving gray iron in acids a much larger quantity of carbon is left than when white iron is treated in the same manner. Now, however, it is known that this inference was erroneous, and that the characters of pig iron are dependent, not upon the greater or less per centage of carbon, but upon the state of combination of the carbon and iron. The gray iron, when suddenly cooled after having been melted, is converted into white iron; and white iron, when exposed to a high temperature after melting, and gradually cooled, is converted into gray iron, without the per centage either of iron or carbon being in any degree altered. Every kind of gray iron corresponds to a white iron with precisely the same per centage of carbon; and the wholly different behavior and characters of these two kinds of iron are no longer regarded as owing to the greater or less per centage of carbon, since it is known that the gray soft iron, malleable at the ordinary temperature, is a mixture of steel-like iron with carbon, while the white, hard, and brittle iron is a true chemical compound of iron with the entire quantity of carbon present.

The analogy between the gray and white pig iron on the one hand, and soft and hardened steel on the other, is unmistakeable; but no trace

of uncombined carbon has ever been found in slowly cooled soft steel. Even cast steel, which contains from 1·9 to 2·0 per cent. of carbon, and which on account of this large per centage can no longer be forged, has never been found to contain uncombined carbon after the slowest possible cooling. It is only when the per centage of carbon amounts to 2·25 or 2·3, that carbon separates in the slowly cooled metal, and communicates to it the characters of true pig iron. If, therefore, a distinction is to be drawn between steel and pig iron, founded upon a character determined by the combining proportions, it would correspond with a per centage of carbon amounting to 2·25 or 2·3, because a part of the carbon is then separated on gradually cooling the mass. The more the per centage of carbon increases from this minimum to the maximum of 5·93, the lighter is the color of the metal and the greater the hardness of the white variety. In the gray iron, on the contrary, the quantity of carbon which separates, and which determines the darker color and greater softness of the metal, as well as the greater or less per centage of carbon remaining in a state of chemical combination with the iron, is dependent upon the more or less solidification of the melted mass. It is therefore not sufficient to know the per centage of carbon in pig iron, as ascertained by analysis, in order to form an opinion as to the behavior of the iron in question; but it is at the same time necessary to determine how much of that carbon is chemically combined with the iron, and how much is present only as a mere mechanical admixture. With regard to the metallurgical processes, the object of which is to separate the carbon from pig iron for the production of steel or bar iron, the state of combination in which the carbon exists is of far greater importance than the total per centage of this element. White iron requires for this purpose methods of processes different from those applicable to gray iron; and cases may occur in which the smelter would be obliged to convert gray into white iron, even although this has to be effected by an addition of carbon, notwithstanding that its separation is the real object of his operations.

Although in the case of pig iron it is necessary to bring it into a liquid state, in order to convert the gray and soft variety into that which is white and hard, or, on the contrary, the former into the latter by rapid or slow cooling of the metal, in the case of iron with a smaller per centage of carbon or steel, mere rapid or slow cooling, without any previous alteration of the state of aggregation, is sufficient to convert the darker colored soft steel into the whiter hard steel, and the reverse. Judging from analogy, therefore, it is highly probable that changes in the state of combination of carbon and iron take place in the hardening and softening of steel, corresponding to the different states of combination of this element in gray and white iron, although these differences in the state of combination have not yet been proved by chemical evidence to exist in the case of steel as they have in raw iron. However, the hard and soft steels have never been regarded as special varieties, and there is no greater reason for regarding white and gray pig iron as special varieties, because the differences in color, hardness, and tenacity are owing solely to the respective states of combination determined by conditions of temperature, and not to any alterations in the combining proportions. If, however, gray and white iron are regarded as special varieties, in the same

manner as graphite and diamond, it must not be forgotten that a perfectly analogous relation exists between hard and soft steels, which are not regarded as special varieties.

In the processes employed for decarbonizing pig iron and converting it into steel, it has not hitherto been possible to obtain a product of perfectly homogeneous nature. It is always necessary to sort the steel, in order to separate the harder parts containing more carbon from the softer, and these again from the steel-like iron. This absence of homogeneity in the product, resulting from the imperfection of the processes, led to an attempt to give the steel great uniformity of texture by melting. The so-called cast steel is really a much more homogeneous and trustworthy product than the raw steel, or that obtained by cementation, although its characters likewise depend upon the proper and careful selection of the material from which it is made. In consequence of the fact, that steel may be prepared by fusion, which, together with a large per centage of carbon and consequent hardness, possesses homogeneity whatever may be the degree of hardness desired, cast steel has acquired such a well merited reputation, that it is now always employed for articles in which great hardness is indispensable. However perfect the process for making cast steel may appear to be, it is still open to the disadvantage that the selection of the suitable material must be entrusted to the judgment of the workman, and consequently that however homogeneous the product, the per centage of carbon, the hardness and solidity of the steel cannot be determined with precision beforehand. Such imperfections in the practice of metallurgical operations are in every case unavoidable, when determinations of weight must be replaced by the practised eye of the workman. The per centage of carbon in the material employed in making cast steel—cementation steel—is different in every part of the section of the bars, so that the average per centage of carbon in the charge of a crucible and the product of the casting cannot be determined with precision. Although the hardness of the English and good German cast steel corresponds tolerably well with that which is required, this result is solely attributable to the perfect acquaintance of the workmen with their materials, and their careful selection of it for this particular purpose. There would be no uncertainty as to the result, if we possessed a material applicable to the preparation of cast steel in which the per centage of carbon could be calculated. The white pig iron made from pure spathic and brown iron ores, free from disseminated copper pyrites, and the per centage of carbon in which may, without any considerable error, be assumed as 5·6,* is a material of this description. The per centage of carbon in the best kinds of Swedish bar iron, and the iron which is made in Germany from pure spathic and brown iron ores, may very safely be assumed as 0·25 on the average. The above pig iron and this bar iron are the purest kinds known, containing only traces of silicium, from which likewise the cementation steel used for making cast steel is never free. Both these kinds of iron are therefore of such a nature as to enable the operator to determine beforehand with precision the per centage of carbon in a crucible-charge, and to produce cast steel of any desired degree of hardness by means of a simple calculation of the requisite proportion of

* Karsten and v. Dechen's Archiv für Mineralogie, vol. xxi. p. 501.

the two kinds of raw material. If the per centage of carbon in the melted product obtained in this way, and the characters dependent upon that per centage, should be found to agree perfectly with calculation—a question to be determined only by experiments on a large scale—it might be expected that the production of cast steel from these materials would constitute a new phase of this branch of industry in Germany; for, besides the trustworthiness of the operation, by which cast steel could be made of any desired degree of hardness and tenacity, it possesses economical advantages in the cheapness of the raw material. These advantages are for German industry of especial importance, from the circumstance that in many provinces of that country the pure white iron with lamellar facets is produced in large quantity, and not at all in other countries.

But the production of cast steel by melting together white iron and pure bar iron, appeared to be liable to an objection far greater than that founded upon the impurity of the raw material, and this arose from the doubt as to whether the product of the fusion would be homogeneous. In my *Handbuch der Eisenhüttenkunde*, (3d edition, vol. iv. p. 512,) I have already expressed an opinion that this would not be the case, and have given the reasons which make it advisable to employ cementation steel for making cast steel, in preference to a mixture of pig iron and bar iron in suitable proportions. However, the question of practicability could only be decided by direct experiment; and it was, for the above mentioned reasons, of sufficient importance to submit it to this test. Such experiments were made in the years 1846 and 1847, at the cast steel and file factory of M. Huth, at Geitebrück, near Hagen, and under the direction of the late Superintendent Stengel, M. Huth having placed his factory at our disposal for the purpose.

The melting crucibles employed were of such capacity, that from 30 to 35 lbs. could be melted at a time. The melted metal was as usual run off into cast iron moulds. The following is a brief statement of the results obtained in a great number of meltings, and the subsequent treatment of the cast steel:—

1. In the selection of the pig iron, it is of great importance to employ such as presents perfect lamellar structure, and not such as is partly fibrous or compact. The use of lamellar iron is necessary, not only in order that the per centage of carbon in the charge may be calculated with accuracy, which cannot be done with fibrous or compact iron, in which the per centage of carbon varies greatly, but likewise and especially because the lamellar iron exercises the greatest solvent action upon the bar iron, so that even a comparatively much larger quantity of these kinds is but an imperfect substitute for the lamellar iron. Consequently, good cast steel cannot be produced in this way without lamellar pig iron.

2. The extremely high temperature which bar iron requires for fusion appeared to render it necessary that it should be added to the charge in small fragments. On this account the first fusions were made with bar iron, which had been rolled into moderately thick sheets and then cut into pieces. However, it was subsequently ascertained that the solution of the bar iron in the liquid pig iron takes place without any difficulty, and that the product is equally good when thick pieces are used, so that finally masses of a cubic inch in dimensions were employed. By this

means the expense of cutting the bar iron is obviated; at the same time the iron is less oxidized, and less room is taken up in the crucible, than when it is in small fragments.

3. In order to produce a homogeneous cast steel, the highest possible temperature is necessary for the fusion. Consequently, very infusible crucibles, which are not liable to crack, are a much greater desideratum in the production of cast steel from pig and bar iron than even in the melting of steel itself. Of course, the greater the number of meltings which can be made in one crucible, the greater is the economical advantage gained.

4. The melted metal must be run off into the cast iron moulds as rapidly as possible, in order that the whole mass may cool uniformly. At the same time care must be taken that none of the slag is allowed to pass from the crucible into the moulds, for there is not time for the slag to separate from the metal; it solidifies in the midst of the steel, and renders the casting defective, and causes the bar to rend in rolling. This may be most advantageously obviated by taking the cover from the crucible while it is still in the furnace, and skimming off the slag with a ladle-shaped iron. The small quantity which then remains may easily be kept back in the ordinary way during the casting.

5. The cast steel, when allowed to cool *slowly* in the crucible, loses all coherence, and breaks down under the hammer or rollers. The cause of this appears to lie in the formation of carburets of iron, which do not remain combined with the rest of the steel containing less carbon.

6. The cast bars must, after they have cooled, be freed from all adhering granules of metal by means of a chisel. If this is neglected, the edges of the bars become broken in rolling.

7. In heating the cleaned bars for the purpose of further working, a bright red heat must be employed. This cannot be effected in a satisfactory manner before a blast, because the temperature is not sufficiently uniform, and a uniform heat is indispensably necessary for the favorable result of the rolling or hammering. This can only be effected in a well constructed reverberatory furnace, and most advantageously in one fed with gas, a slight excess of which is present.

8. It is preferable to roll the heated bars rather than to hammer them; but if a hammer is used, it must be of considerable weight.

9. The cast bars presented a perfectly homogeneous appearance, even after rolling. The bars were first rolled out square to a length of 4 feet, and then after reheating brought into the desired form. They admitted of being rolled into the thinnest sheets without cracking at the edges.

10. Even in making soft steel, for which purpose the crucible was charged with 25 lbs. of bar iron and 2 lbs. of pig iron, a perfect solution of the bar iron was effected by means of a strong heat. The product was a homogeneous steel, although, according to calculation, it could not contain more than 0·6 per cent. of carbon. The best, hardest, and most tenacious steel was obtained by fusing mixtures in which the calculated per centage of carbon was 1·5 or 1·6. For this purpose the crucible was charged with 24 or 25 lbs. of bar iron and 8 lbs. of pig iron.

11. The cast steel, even that which is soft and in which the per centage of carbon is only 0·6, differs essentially from the raw or melted steel

in the circumstance that it cannot be welded without great difficulty. With a higher per centage of carbon, it can only be welded under a coating of borax. With a per centage of 1·25, it can no longer be welded at all. Although, on the one hand, this behavior of the cast steel obtained in this way indicates its homogeneity, still it is a defect, one indeed which is likewise possessed by the English cast steel in a somewhat less degree.

12. The cast steel bears only low tempering heat, and acquires a very high degree of hardness, although at the cost of its tenacity. The proper mode of tempering it still remains to be ascertained.

13. The steel may be used for making the finest kinds of cutlery for files and chisels. For all purposes in which it is submitted to sudden and violent blows, it has proved destitute of the requisite tenacity. While very hard, it possesses considerable brittleness.

14. The last mentioned character of the steel affords ground for doubting its certainly apparent homogeneity, and this conjecture is confirmed by the fact, that its tenacity and capability of being welded are considerably increased by remelting. If, however, it should prove to be impossible to produce a good cast steel in one melting, the economical advantages of this process would probably be altogether lost.

The further prosecution of these experiments has unfortunately been interrupted by the long illness and death of Superintendent Stengel, who had for a number of years afforded me valuable aid in carrying out a variety of experiments, which appeared to me to be necessary for the purpose of throwing some further light upon the metallurgy of iron.—*Karsten and v. Dechen's Archiv*, vol. xxv, p. 218.

New Photographic Process. By JOHN STEWART.*

Your insertion of the annexed letter from my brother-in-law, Mr. John Stewart, of Pau, will much oblige me. The utility of this mode of reproduction seems indisputable. In reference to its concluding paragraph, I will only add, that the *publication* of concentrated microscopic editions of works of reference, maps, atlases, logarithmic tables, or the concentration for pocket use of private notes and MSS., &c., &c., and innumerable other similar applications, is brought within the reach of any one who possesses a small achromatic object glass of an inch or an inch and a half in diameter, and a brass tube, with slides before and behind the lens of a fitting diameter to receive the plate or plates to be operated upon, central or nearly central rays only being required. The details are too obvious to need mention. I am, &c.,

J. F. W. HERSCHEL.

Hanley Street, July 6.

DEAR HERSCHEL:—I sent you some time ago, a few small sized studies of animals from the life, singly and in flocks, upon collodionized glass. The great rapidity of exposition required for such subjects, being but the fraction of a second, together with the very considerable depth and

* From the London Athenæum, July, 1853.

harmony obtained, gave me reason to hope that ere this I should have been able to produce microscopic pictures of animated objects. For the present, I have been interrupted. Meantime, one of my friends here, Mr. Heilman, following the same pursuit, has lighted on an ingenious method of taking from glass negatives positive impressions of different dimensions, and with all the delicate minuteness which the negative may possess. This discovery is likely, I think, to extend the resources and the application of photography, and with some modifications, which I will explain, to increase the power of reproduction to an almost unlimited amount. The plan is as follows: the negative to be reproduced is placed in a slider at one end (*a*) of a camera or other box, constructed to exclude the light throughout. The surface prepared for the reception of the positive, whether albumen, collodion, or paper, is placed in another slider, as usual, at the opposite extremity (*c*) of the box, and intermediately between the two extremities (at *b*) is placed a lens. The negative at *a* is presented to the light of the sky, care being taken that no rays enter the box but those traversing the partly transparent negative. These rays are received and directed by the lens at *b* upon the sensitive surface at *c*, and the impression of the negative is there produced with a rapidity proportioned to the light admitted, and the sensibility of the surface presented. By varying the distances between *a* and *c*, and *c* and *b*, any dimension required may be given to the positive impression. Thus, from a medium sized negative, I have obtained negatives four times larger than the original, and other impressions reduced thirty times, capable of figuring on a watch glass, brooch, or ring.

Undoubtedly, one of the most interesting and important advantages gained by this simple arrangement is, the power of varying the dimensions of a picture or portrait. Collodion giving results of almost microscopic minuteness, such negatives bear enlarging considerably without any very perceptible deterioration in that respect. Indeed, as regards portraits, there is a gain instead of a loss; the power of obtaining good and pleasing likenesses appears to me decidedly increased, the facility of subsequent enlargement permitting them to be taken sufficiently small, at a sufficient distance (and therefore with greater rapidity and certainty) to avoid all the focal distortion so much complained of, while the due enlargement of a portrait taken on glass has the effect, moreover, of depriving it of that hardness of outline so objectionable in a collodion portrait, giving it more artistic effect, and this without quitting the perfect focal point as has been suggested.

But there are many other advantages obtained by this process. For copying by engraving, &c., the exact dimension required of any picture may at once be given to be copied from.

A very small photographic apparatus can thus be employed when a large one might be inconvenient or impracticable, the power of reproducing on a larger scale being always in reserve. Independent of this power of varying the size, positives so taken of the *same* dimension as the negative reproduce, as will be readily understood, much more completely the finer and more delicate details of the negatives than positives taken by any other process that I am acquainted with.

The negative also may be reversed in its position at *a* so as to produce

upon glass a positive to be seen either upon or under the glass. And while the rapidity and facility of printing are the same as in the case of positives taken on paper prepared with the iodide of silver, the negatives, those on glass particularly, being so easily injured, are much better preserved, all actual contact with the positive being avoided. For the same reason, by this process positive impressions can be obtained not only upon wet paper, &c., but also upon hard inflexible substances, such as porcelain, ivory, glass, &c., and upon this last, the positives being transparent are applicable to the stereoscope, magic lantern, &c.

By adopting the following arrangement, this process may be used largely to increase the power and speed of reproduction with little loss of effect. From a positive thus obtained, say on collodion, *several hundred* negatives may be produced either on paper or on albumenized glass. If on the latter, and the dimension of the original negative is preserved, the loss in minuteness of detail and harmony is almost imperceptible, and even when considerably enlarged, is so trifling as in the majority of cases to prove no objection in comparison with the advantage gained in size, while in not a few cases, as already stated, the picture actually gains by an augmentation of size. Thus, by the simultaneous action, if necessary, of some hundreds of negatives, many thousand impressions of the same picture may be produced in the course of a day.

I cannot but think, therefore, that this simple but ingenious discovery will prove a valuable addition to our stock of photographic manipulatory processes. It happily turns to account and utilizes one of the chief excellencies of collodion, that extreme minuteness of detail which from its excess becomes almost a defect at times, toning it down by increase of size till the harshness is much diminished, and landscapes, always more or less unpleasing on collodion from that cause, are rendered somewhat less dry and crude.

A very little practice will suffice to show the operator the quality of glass negatives, I mean as to vigor and development, best adapted for reproducing positives by this method. He will also find that a great power of correction is obtained, by which overdone parts in the negative can be reduced and others brought up. Indeed, in consequence of this and other advantages, I have little doubt that this process will be very generally adopted in portrait taking.

Should your old idea of preserving public records in a concentrated form on microscopic negatives ever be adopted, the immediate positive reproduction on an enlarged readable scale, without the possibility of injury to the plate, will be of service.

I am, &c., JOHN STEWART.

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*Application of the Pendulum to the Determination of Velocities.**

The invaluable instrument which we call a pendulum has been applied to an infinity of objects, and always with characteristic advantages in point of precision or sensibility. It was only recently that by a new application of it, the most lofty in its object, and the most ingenious in its nature, it was made to render visible the rotation of the globe. Per-

* From the London Mechanic's Magazine, June, 1853.

haps it was in reflecting on this elegant experiment that I have been led to the thought of another kind of application, which, without participating in the same elevated character, recommends itself by having in view an end of real utility, that end having reference to the determination of velocities. And although I may not as yet be in a condition to confer upon this new employment of the pendulum the seal of practical trial, as, nevertheless, the principle of it seems to me sufficiently demonstrated by experiment, I ask that the Academy will permit me to make it acquainted with its nature in a few words, in order, in the first place, to draw its attention to a view which appears to me new, and, in the second place, in order to protect our priority during the course of experiments and of researches, which may possibly have rather a long duration.

The question with which we are dealing is, the application of the pendulum to the measure of the real velocity of vehicles; that is, their velocity referred to the centre of the earth. In everything that concerns navigation, the importance of such an object will be immediately perceived. There exist, indeed, several precise and convenient means of measuring the speed of trains on railways, for example, where the point of support between the wheel and the rail remains fixed, (as distinguished from slipping,) it is sufficient to be able to assign the rapidity of rotation of the wheels. But at sea the case is very different. The sea is subject to currents, of which the extent, the direction, and the velocity are never but imperfectly known. The sustaining point is thus itself transported in one direction or the other, and the log, the only elementary and non-astronomical means of measuring the speed of ships, gives, under any circumstances, only the difference between it and that of the surface of the water. On the contrary, it is possible to ascertain the real speed of the vessel by the indications of the pendulum, of which I am about to endeavor to explain the principle.

Suppose that a pendulum beating, say half-seconds, and carrying a bob weighing a few grammes (a gramme is equal to 15·44579 grains Troy,) be suspended in such a manner that its plane of oscillation may be parallel to the axis of progression of the vehicle. If the pendulum be vertical, the bob and the point of suspension being subjected to the same velocity, it would remain in the same state for an indefinite period, making abstraction of irregularities of motion, and derangements of various kinds. But if, by a small impulsion given by the hand in a direction contrary to that of the motion of the vehicle, the bob be made to recede a little from the vertical, the velocity of the point of suspension then produces upon it a tractive force through the instrumentality of the rod, which has become inclined to the horizon. That traction has a horizontal component, and ought, consequently, to draw forward the centre of the little mass, with a force proportionate in its intensity to the speed of the vehicle. In falling back again, and after having retrogressed a little behind the vertical, as soon as the obliquity of the rod has become sufficient, the same traction will exert itself anew, and the bob will recommence the same oscillation forwards, under the influence of the two forces of traction and gravity. Without knowing precisely the law of these two combined actions, we may nevertheless conjecture that the pendulum, under these

circumstances, would take a deviation forwards, great or small in proportion to the velocity of traction, and remaining sensibly constant if the same speed were maintained. An experimental graduation might then teach how, for a pendulum of given length and weight, to measure the speed of the vehicle on which it was carried, by observing its deviation in front of the vertical.

Such is the principle on which I have reflected, and which I have desired to subject to experiment, to recognise, in the first place, its reality, and then the possibility and the sensibility of a measure so contrived. Moreover, it is very easy to obtain this verification by an experiment to some extent manual, I not having been able, as yet, notwithstanding several attempts, to construct an apparatus capable of going by itself continuously, and destroying the effect of the various kinds of derangements and irregularities which the hand can extinguish. I do not attempt in this place, therefore, to give an exact measure of the phenomenon, but only to prove the principle of it by an experiment easily reproduced, and which, from being deprived of elegance, is not in substance less decisive.

If we get into a railway carriage, and resting our arm against a vertical support, hold a pendulum suspended in connexion with a graduated arc of a circle, in conformity with the conditions indicated above, and if, with a proper amount of attention, we preserve this instrument as much as possible from the effect of lateral shocks and vertical movements, we may observe the following result: We shall hardly have given to the bob a slight retrograde impulse, than, under the influence of traction, we shall see it almost immediately spring forwards through an angle which, for an ordinary speed of 28 miles an hour (10 *lieues*), will soon increase to about 33 degrees. In falling back, on the contrary, the backward deviation is hardly 5 or 6 degrees, and the same motion continuing so long as the velocity lasts, there is thus a very considerable and permanent inequality between the two branches of the oscillation. This is, in some degree, the characteristic part of the phenomenon. If, in this state of things, the velocity of traction should diminish, the direct deviation diminishes nearly as rapidly; and I have never failed, in experimenting in this manner, to become aware of my approach to a station, without taking my eyes off my pendulum.

The inequality between the two branches of the oscillation is also sensible for inferior velocities, and for less than 28 miles an hour, and we still see the pendulum advance 10 degrees before the vertical. The rate of ships being ordinarily comprised between 6 and 18 miles per hour (2 and 3 *lieues*), the variations of amplitude corresponding to such velocities have a very appreciable sensibility. That sensibility, besides, is susceptible of augmentation, by varying the length or the weight of the pendulum. I am not able at present, however, to say anything certain on the subject. It is clear that there must be certain dimensions which will belong to the maximum of effect: but as to that, experiment does not always bear out suppositions of a complicated and difficult nature, and it is experiment that will have to pronounce.

If we wish to arrive at true precision in the kind of measure of which I have been speaking, the great and real difficulty lies evidently in the construction of apparatus capable of protecting the point of suspension of

the pendulum, whether from jerkings and shocks on a railroad, or, above all, from the pitching and rolling of a ship. It is upon this point that my researches are being directed. Already I have made some attempts, and it was to try to combine these several dispositions that I seek to improve our prospects, as regards time, by this communication. Perhaps it never will be possible to obtain an apparatus of continuous action, nor an apparatus capable of working independently of the manual address of the operator. But many very useful instruments are precisely in the same condition; and with regard to continuity, it will be sufficient for me to call to mind, that in ships in motion it is only customary to throw the log three or four times a day. If, however, we should only succeed in affording the means of measuring speed in calm weather, in an intermittent manner, and even under conditions essentially manual, but with a light instrument, of elementary simplicity, easy to construct and to repair, I think we shall have attained an end of unquestionable utility, and it is the hope of that result that attaches me to the prosecution of this research.

For the Journal of the Franklin Institute.

Evolution of Steam.—Experiments Proposed.

Among the countless attempts at economy in the steam engine, I am not aware of any that have for their object a more rapid evolution of vapor by introducing in small quantities into boilers, a thinner and more evaporable liquid than water; one that by penetrating the latter shall render it more permeable to and be the medium of more rapidly and intimately diffusing heat through it. A crude preliminary experiment or two, in which small doses of whiskey were tried, resulted in nothing definite, one way or the other, on account of the lame apparatus employed, and the pressure of other engagements at the time. Circumstances have hitherto prevented their resumption under better auspices. The subject is commended to the attention of chemists.

It may, perhaps, be a question with some, whether there exists, or is attainable, a cheap liquid possessing the qualities named; but there is no doubt that a fluid which is every where abundant, and costs nothing, greatly accelerates the evaporation of liquids, when passed through or mingled with them, viz: common air; and to determine the profit or loss attending its use in steam boilers, was another object postponed. Will not some readers of the *Journal* adapt an air-feeding apparatus to a boiler, and give us the results? I presume it would be well (to secure a pretty uniform discharge of the fluid) to have a reservoir, like a small soda fountain, between the feed pump and the boiler. The tube within the latter should be continued along the lower part, and be perforated laterally with small openings, that the issuing air may minutely agitate, break, and, in a manner, comminute the heated liquid it touches.

The increased volume of the air will, it is supposed, pay the cost of injecting it, and of the heat taken up by it, leaving the benefit of accelerated evaporation, whatever it may be, a clear gain. E.

*Art-Manufacture.**

We are under a sort of conditional promise to our readers, who feel all the value and importance of the results obtained from the Great Exhibition, to return to the encyclopædic volume which contains the records of that unparalleled display. The Great Industrial Exhibition at Dublin has naturally turned back our thoughts to our own Great Exhibition, of which it is a worthy follower. The Dublin Exhibition has a much larger proportion of Fine as compared with Industrial Art than had that in Hyde Park; and the genius of the Irish nation makes it more than probable that she will, in time, be eminent amongst the united nations in applying fancy and taste to the productions of the artizan. For this reason, we turn to-day to the Report of the Fine Arts Department of the Exhibition in Hyde Parke;—which may be looked on as one of the proximate causes of the deep interest that the subject of Art-education has recently excited in the public mind. But there is another circumstance which induces us at this moment to recur to the Report of the Fine Arts Committee:—namely, the move made by the Lord Mayor of London towards enlisting the corporate bodies of the United Kingdom in the interest of Art education. In a few days, the representatives of a large number of the great towns in the three Kingdoms will assemble at the Mansion House to discuss the modes by which artizans may be best assisted in obtaining such an amount of artistic education as will enable them to compete with the workmen of other nations, where more attention has been given to the study of ornament and its application to manufacture. We hail it as a sign of the times, that such a subject should occupy the attention of mayors and aldermen; and we think we shall be assisting the movement by calling attention to the judgment which has been passed by well-qualified persons on our present position with respect to Practical Art.

The great importance attached by the Royal Commissioners to this department of the Great Exhibition, and the sense entertained by them of the value of the lessons which it could furnish, are evinced by the prominence given to it in the Reports before us. Each of the other classes of that magnificent collection which existed but the other day on the spot over which the plough has recently passed, is dealt with in a single Report; but in this case we have, in addition to the categorical account by Mr. Panizzi, the reporter of the Jury, a Supplemental Report by Dr. Waagen, Director of the Museum of the Fine Arts at Berlin, and a "Supplementary Report on Design," by Mr. Redgrave, R. A., who had long been connected with the Schools of Design here, and who is now Art-Superintendent of the new Department of Practical Art at Marlborough House.

The Class, as our readers will doubtless well remember, included sculpture, models, the plastic arts, and ornament generally. It is not our intention, on the present occasion, to touch on the province of High Art, except incidentally. We confine ourselves just now to that part of the Report which refers to Art in connexion with manufactures and with public taste.

* From the London Athenæum, May, 1853.

We have felt compelled frequently of late to draw attention to the great want of artistic education in England;—a fact not gratifying to our national vanity to admit,—but which, being proved, demands to be discussed until efficient means shall have been taken to supply it. The Reports to which we have referred place the matter beyond doubt,—and at the same time point out the course that should be pursued under the circumstances. The evidence of so eminent a foreigner as Dr. Waagen is of great value, and his testimony against us has the greater force from the fact that he is amongst all the critics who have written on the subject perhaps the most lenient in his judgments on the productions of this country.

In his opening remarks, the Doctor dwells on the intimate connexion between Manufacture and the Fine Arts. In the great markets of the world, he says, those productions which, in addition to the indispensable requisites, exhibit the best taste in their design and treatment, will be preferred. He anticipates as one of the good results of the Exhibition a fuller revival of that happy alliance between the Fine Arts and Industry which subsisted in the Middle Ages, when the artist was more of a craftsman—the craftsman more of an artist—than is the case at present; and he refers to the wonderful specimens of casting in bronze, iron, and zinc —an art as regards the two latter metals only recently perfected—which were to be seen at the Exhibition, as affording striking examples of the co-operation of Art and Manufacture in our day. He adds:—"To the present age are also due two most valuable and original inventions by which works of the sculptor may be reproduced;—in the one case by means of galvano-plastic deposit,—in the other by the mechanical processes of M. Collas, in France, and Mr. Cheverton, in England. The cheapness with which the noblest works of Art can be multiplied by means of these inventions cannot but tend to the more general development of a feeling for the Beautiful. Of Mr. Cheverton's elegant reduction of the Theseus in the Elgin collection, he says, it "has been reduced by this process in alabaster, for the purpose of casting in plaster, with an accuracy which leaves the most fastidious critic nothing to desire." And he adds:—"The benefit which all lovers of Art, and more particularly artists themselves, will derive from this discovery, are so obvious, that I need not further insist on them here." This part of the subject is further illustrated in the remarks on the productions of Minton, Copeland, Meigh, Wedgwood, Bell, and other China manufacturers, and on the great influence that they must have in creating a correct taste by making the public acquainted with such exquisite productions as the celebrated silver cups in the Museo Borbonico or the Farnese Flora, and generally in the judicious choice and adaptation of beautiful forms from the antique.

The Jury, through their reporter, Mr. Panizzi, touch on the same subject; and allude to the fact, that the best models are daily introduced to the public by new applications of cheap materials and economic processes to the multiplication of works of Art: thus affording to the many new and pure sources of enjoyment which have hitherto been within the reach of only the more fortunate classes. It is well remarked that such a diffu-

sion of good taste cannot possibly be without a beneficial effect on the productions of industry generally.

Mr. Redgrave, in the opening of his Report, alludes to the desire evinced by the rudest as well as by the most civilized nations for decoration, as raising ornament almost to the rank of a natural want. He dwells on the great importance of its proper application by the manufacturer, and on the necessity of bringing criticism to bear upon the subject, so as to prevent the untutored eye from being attracted by the meretricious style of ornament unfortunately so common, rather than by the more modest appearance of simple and elegant forms.

In commenting on the articles in the several divisions of the Class, the reporters take great pains to indicate the principles on which ornament should be applied. In the case of designs for printed and woven fabrics, for embroidery, and for bookbinding, the designs must not disturb the flatness of the surface upon which they are drawn, but only diversify it by lines agreeable to the eye and by harmonious coloring. In such designs no foreshortening or perspective is admissible. Paper hangings covered with elaborate architectural designs, conveying the idea that the observer can see through and beyond the surface into space, curtains covered with huge flowers which are contorted by every fold in the fabric, books with Gothic churches on their covers, and carpets in which the surface appears covered with objects thrusting obstructions at every step, are severely condemned as gross violations of good taste. In the fabrics of India, the patterns and colors diversify plain surfaces without destroying or disturbing the impression of flatness; as is the case also in the productions of the Middle Ages, when the decoration of walls, pavements, and carpets was brought to such perfection by the Arabs. These productions are nevertheless remarkable for the rich invention shown in the patterns; and the beauty, distinctness, and variety of the forms, and the harmonious blending of severe colors, call forth the admiration of all true judges of Art. "What a lesson," says Dr. Waagen, "do such designs afford to manufacturers, even in those nations of Europe which have made the greatest progress in industrial art?"

Speaking of paper and other hangings, Mr. Redgrave points out the necessity for attentively considering the intention of such decorations. Like the background of a picture, they should be so subdued as not to come into contrast with the objects which they are intended to exhibit, not to rival. A wall decoration is the background for the furniture, the objects of Art, and the occupants of the room. It may, by presenting a glaring appearance, detract from their effect, but it cannot properly supply their place, however attractive or showy it may be in itself. A combination of many colors materially increases the expense of a paper, while it does not produce the same good effect as may be obtained from two or three colors carefully selected, and frequently results in an appearance of poverty and meanness. It is quite certain that the walls, floor, and ceiling of a room should not eclipse its contents; but looking upon the excessive ornamentation which is at times lavished on the ceiling, the glowing colors with which many of our paper-hangings are covered, and the flowers, fruit, animals, and birds that shine out from some of our

carpets, it is difficult to conceive a room furnished with such magnificence as not to suffer by the vicinity of such showy productions.

Few, if any, of the European nations escape censure on some of the points to which we have referred; but Dr. Waagen—impartial as he is—arrives at the conclusion, "that in many kinds of manufacture the English productions, both in regard to their form and color, show far less taste than those of other nations."

The cases in which our inferiority is most conspicuous, are those in which the ornamentation is effected wholly by machinery. This partly arises from the facilities which machinery gives to the manufacturer, enabling him to produce the florid and overloaded as cheaply as the simple forms, and thus to satisfy the craving of the multitude, who value a decoration according rather to the quantity than to the quality of its ornament.

As an instance of this vicious style, Mr. Redgrave refers to some paper hangings exhibited as specimens of the lately introduced processes of printing by such machinery as is used for cotton goods, and of applying many colors from one block. The new processes offer the means of applying a large number of colors at a small expense; and as a large number of colors is unfortunately popular in the market, this new and ingenious mode of printing is likely to have a very bad effect upon the cheaper sorts of paper hangings.

It may at first seem strange, that when articles are to be produced by thousands and tens of thousands, manufacturers should not be particularly careful that the original design, at any rate, is as good as can be obtained: but in the race for the lowest price, every extra pound expended adds something to the cost per yard, and the odd farthing is the advertisement that brings the millions to the cheap shop. There can be no doubt that half the ornament at the Great Exhibition was in excess,—that is to say, a better effect might have been produced without it; and the labor thus wasted might, in many cases, have been bestowed on the more careful completion of simpler designs, to the enriching of the manufacturer and the great advantage of the public taste.

The productions of English manufacturers are pronounced by the Reporters to exhibit at once too great a love for ornament and a want of inventive ingenuity. The consequence of this is, that there is no special style in their productions. One class worship at the mediæval shrine, and adapt the forms of the early workmen to everything that they produce: others go to the classic regions of Greece and Rome, and raise to the dignity of models everything that is stamped with the seal of antiquity—no matter whether he who originally produced it was a man of taste, or some unknown provincial artist whose productions would have been viewed by the *savans* of his time in much the same light as a well-educated architect of our own day regards some of our curious specimens of "Builders' Gothic," Grecian or Egyptian. These are the artists who hold by tradition, and look on the past as the source of all that is deserving of imitation. Another great section of ornamentalists—indeed of the professors of high art also—discard all the works of their predecessors,

and, determined to create for themselves something of a novel character, seize upon the beautiful forms of nature, and use them as the raw materials of everything which they wish to be produced.

To be Continued.

For the Journal of the Franklin Institute.

Particulars of the Steamer Golden Age.

Hull built by Wm. H. Brown; machinery by the Morgan Iron Works. intended service, Australia.

HULL.—Length on deck,	270 feet.
Breadth of beam, at midship section above the main wales,	43 "
Depth of hold,	24 " 4 inches.
Length of engine and boiler space,	92 "
Draft of water at below pressure and revolutions,	14 " 9 "
Area of immersed midship section at this draft,	552 square feet.
Capacity of coal bunkers, in tons of coal, 600	
Draft of water at load line,	17 feet.
Floor timbers at throats, moulded	18 inches.
do. do. sided,	12 "
Frames, distance apart at centres,	36 "
Masts and rig, Barque.	
Tonnage, 2376 tons.	

ENGINE.—One Vertical beam.

Diameter of cylinder,	83 inches.
Length of stroke,	12 feet.
Maximum revolutions per minute, 16	

BOILERS.—Two, double boilers, drop flue, with furnace at each end, and one connexion in the centre.

Length of boilers,	38 feet.
Breadth "	14 " 9 inches.
Height " exclusive of steam chimney,	12 "
Number of furnaces in both boilers, 16	
Length of grate bars,	6 "
Number of flues, (main flue,) 8	
Internal diameter of flues,	16¼ inches.
Diameter of smoke pipe,	8 feet 4 inches.
Height of smoke pipe,	41 "
Maximum pressure of steam in pounds, 25	
Description of coal, Bituminous.	
Consumption of coal per hour, 1⅞ tons.	
Area of flue and fire surface in boilers,	5854 feet.

WATER WHEELS.—

Diameter,	34 feet 6 inches.
Length of blades,	9 " 6 "
Depth of blades,	1 " 11 "
Number of blades, 28	

Remarks.—Strapped with diagonal and double laid braces, $5 \times \frac{3}{4}$ inch; coppered.

Translated for the Journal of the Franklin Institute.

Analysis of a Report by a Government Commission, on Experiments made on board of the ship Du Trembley, *upon the use of the combined vapors of Water, Ether, and Chloroform.*

The ship *Du Trembley* is of iron, arranged for carrying both passengers and freight, and to run both by sails and by steam.

It can accommodate 100 travelers, and carry 230 tons of freight; an elegant schooner rig, and a screw moved by machines of 70 horse power, are so arranged as to be used either together or separately.

The peculiarity of the *Du Trembley*, which is the motive for the report upon its first trip by the undersigned members of the Committee of Superintendence of Marseilles and Algiers, is that its machines are arranged to work by the combined vapors of water and ether.

The employment of these two vapors to give motion simultaneously to the same machine, is a new system due to M. Du Trembley, whose name has been given to the ship of MM. Arnaud and Touache, the first to which it has been applied.

Struck by the loss of heat by steam in ordinary machines, after its expansive force has been exhausted, M du Trembley determined to retain and utilize it. For this purpose he proposed to employ it in forming a second vapor, whose force should be added to that of the steam.

Sulphuric ether requiring but a feeble heat to volatilize it, appeared to him fitted to realize his idea; he made the experiment, and the result fulfilled all his hopes. As soon as the vapor of water was in contact with the ether, it fell instantly in the liquid state, and the ether evaporated. On the one hand, a new expansive force was created; on the other, a vacuum, which is also a force, was formed.

The problem which M. du T. had proposed to himself, was theoretically and successfully resolved; it still remained for him to devise the mechanical apparatus by which he might apply in practice the result which he had obtained; he has been not less fortunate in this second part of his work than the first.

He receives the expanded steam, that is, after its force is expended, at its issue from the cylinder, in a closed apparatus, traversed vertically by a considerable number of small cylinders, close together, but isolated. The feet of these small cylinders plunge into a reservoir of ether placed under the apparatus which receives the steam; the ether rises in the tubes, and partially fills them.

As soon as the steam has penetrated into the apparatus traversed by the tubes, and has surrounded them entirely, the phenomenon of which we have spoken takes place; the water condenses, the ether vaporizes. The water in condensing produces a vacuum, which adds to the expansive force of the steam by suppressing the resistance which it would have encountered; and the vapor of ether collected in a separate compartment above the vaporizing apparatus into which the tubes open, developes a new force, which is added to that of the steam.

The condensed water is pumped back into the boiler, carrying back with it all the heat which the ether has not taken from it.

The vapor of ether is led into a separate cylinder used for it alone, but not differing in any respect from the steam cylinder; in this cylinder its force is utilized. The piston of this second cylinder may act either independently or may be connected to the same shaft as that of the steam cylinder; in this latter case the two vapors unite in the same work. This is the case in the *Du Trembley*, and ought to be the case in the applications of the new system to navigation.

The vapor of ether, which for many reasons it is very important not to lose, or to suffer to escape, is treated as the steam was; it is introduced into the tubes of an apparatus, like the vaporizer, whence comes a continuous jet of cold water, which fills the apparatus and surrounds the tubes as the steam does in the vaporizer.

The ether restored to the liquid state, is pumped back into the vaporizer, as the condensed water was into the boiler, to recommence the circulation we have described.

Such is the system of combined vapors due to M. du Trembley; succinct as is the description of it which we have given, it will be sufficient to explain the principle upon which the system rests, and to show that there may result from its application a notable diminution of combustible compared with that required for steam alone.

In the course of our trips, we made experiments on the quantity of fuel consumed. They lasted altogether 36 hours and 50 minutes, and took place very nearly in all kinds of weather, and under all conditions; besides, whatever was the state of the weather and of the wind, whether the machines alone drove the vessel, or whether they were assisted by the sails, the force which they expended was nearly constant, and about 70 horse power, as was indicated by the very slightly changeable position of the indexes of the manometers which measured the pressures and vacuums.

The quantity of fuel consumed in the 36 hours 50 minutes, during which our experiments lasted, was 2860·9 kil., regularly and carefully weighed; that is, as a mean 77·67 kil. per hour, or 1·11 kil. per horse power, admitting that the power of the machines was 70 horse, or 1·16 kil., if we count them but as 67 horse power, (1·11 kil.=2·5 lbs.)

Before working with the combined vapors, the engines of the *Du Trembley* were worked under the same pressure, and consequently with same force, with steam alone acting in the two cylinders. They consumed, according to the ship's log and the books of the furnishers, for 2818 hours of heating, 851·95 kil. of fuel; per hour, 302 kil.; per horse power, 4·31 — 4·51 kil. (9·5 — 9·9 lbs.)

According to this calculation, there will have been obtained, by the introduction of the vapor of ether, an economy of fuel, on that expended when the two cylinders were driven by steam alone, of 3·2 *to* 3·35 *kil. per hour, or per horse power* 74·26 *per cent.—a result so good that we scarcely dare believe it, notwithstanding that the exactness of the numbers on which our calculations are based has been again affirmed to us, and differs little from that which our own experiments give.*

We found the consumption of charcoal 1·11 kil., or 1·16 kil. per hour per horse power; the best constructors do not go below 4 kil., as that stipulated in their contracts as the minimum consumption of their en-

gines, which shows an economy of 2·89 kil., or 2·84 per horse power per hour, or from 71 to 72·25 per cent., a result but little below the preceding.

Besides, whether this calculation and its results be more or less rigorously exact, which further experiments will show, we consider it as settled and incontestible that, in reference to the consumption of fuel, the system of M. Du Trembley presents a notable economy; and that the expense of the ether, far from counterbalancing the advantages of this economy, scarcely changes the result.

As to the dangers inherent in the use of ether, they are the same, neither less nor greater than those belonging to lighting by carburetted hydrogen gas. The same arguments may be used against the employment of ether in steam engines as were presented when the lighting by gas was discussed. These arguments will avail no more now, than they did then against real advantages, and a remarkable economy.

One of the greatest difficulties which the inventor had to overcome was, the exact and sufficient closure of the joints, for the subtlety of ether and the ease with which it inflames are known. But M. Du Trembley has succeeded in closing the joints of his apparatus with such accuracy, that he can affirm, say the committee, that if a slight odor announces the presence of the ether when the engines, already heated, are at rest, this odor entirely disappears when the ship is in motion.—*Cosmos, 12th August*, 1853, *p.* 269.

For the Journal of the Franklin Institute.

Chloroform Engines.

The French Journals record a successful experiment at the port of L'Orient, with a steamship of 120 horse power, (the *Galileo*,) using the vapor of chloroform. No details are given of velocity or power; but it is said that her apparatus occupies but half the space of that of ordinary steam vessels, and that an economy of 50 per cent. of combustible was obtained.

We will wait for the details of the experiment, and for a larger experience as to the loss of chloroform, before we give our implicit credence to this economy.

Translated for the Journal of the Franklin Institute.

Chinese Magic Mirrors Explained.

A great deal of attention has been given in Europe to certain metallic mirrors fabricated in China—in which forms of letters, flowers, and animals are embossed on the back, which is not polished. On looking directly and as closely as possible on the polished face, no trace of these figures is seen; but if the mirror is made to reflect the rays of the sun upon a wall or screen, the ornaments on the back are plainly seen in the reflected light. Many attempts have been made to explain this phenome-

non, but hitherto unsuccessfully. On the 1st of April, however, M. Biot exhibited to the Academy of Sciences in Paris, one of these mirrors, made by M. Lerebours. It appears that in 1847 MM. Arago and Biot suggested an explanation, founded on the fact, that as the embossing of the back surfaces gave different thicknesses, and therefore different resistances to the metal, when the face came to be polished, the surface opposite the raised portions would be more resistant, and would be raised in a convex form, while that opposite the hollow would under the same pressure be slightly concave—these effects being so slight as to be invisible to an ocular examination of the surface, but becoming manifest by the deviations impressed on the reflected rays. To test this theory, M. Lerebours took an ordinary daguerreotype plate of copper plated with silver, and on the copper back he engraved a crescent, and then polished the plate. Looking directly on it and as carefully as possible, nothing is seen; but when the sun's rays were received on the plate and thrown on a screen, the form of the crescent was clearly defined in the reflected image, darker or lighter than the rest, according to the distance of the mirror from the screen.—*Cosmos*, *5th August*, 1853.

Photography on Stone. By MM. Barreswil and Lemercier.*

The process proposed by the authors consists in preparing a negative on paper, and then producing a positive picture on lithographic stone. The negative is obtained by any method, the most rapid being preferable. The positive is produced by a fatty or resinous coating laid on the stone, and capable of being rendered soluble in some solvent by the action of light (and perhaps of oxygen). The negative is laid upon the lithographic stone thus prepared, and covered with a glass plate; the whole is then exposed to the sun, the stone washed with the solvent, and then treated by the ordinary processes of lithography. The authors have hitherto employed asphaltum for coating the stone, and sulphuric ether as the solvent. They expect in this manner to reproduce engravings, lithographs, &c.—*Comptes Rendus*, May 16, 1853, p. 878.

An Enormous Cog-Wheel.†

Messrs. Randolph, Elder & Co., Engineers, of Glasgow, have just completed the largest cog-wheel ever made. It is intended to drive the screw propeller of one of the leviathan steamers now building by Messrs. Tod and M'Gregor. It has been found in practice preferable to have the propeller shaft driven at a velocity much greater than can be conveniently attained by the direct action of the engines, and hence the employment of a wheel and pinion to bring up the speed of the screw shaft to about threefold that of the engines; and in order to deaden the jarring sound produced by metal wheels working together, the large wheel is fitted with wooden wheels or cogs, those of the pinon being iron. The result of this

* From the London Chemical Gazette, No. 258.

† From the London Civil Engineer and Architect's Journal, July, 1853.

combination is, a smoothness and noiselessness of motion hardly to be expected in such ponderous mechanism.

The cog-wheel at present being fitted up is 13½ feet in diameter, 5 feet 8 inches broad on the face, and weighs upwards of 30 tons. There are two sets of arms, of six each, firmly bolted to the inside of the periphery and to each other. There are four rows of cogs breaking joint, each row consisting of 110 teeth, formed of beech, nicely fitted into their sockets, and then shaped off to a shaving by a machine to their exact pitch and position. But perhaps a more popular idea of the enormous size and strength of this wheel will be conveyed by the fact, that the wooden teeth alone will weigh upwards of three tons. The entire ring is one piece, and must have been an extremely difficult piece of work to cast, as there are no less than 880 openings left through its circumference, and all accurate as to size and position, in which the wooden teeth have to be inserted and secured. The main shaft of the engine passes through the eye of this wheel, with a crank on each end placed at right angles. The pinion is one-third of the size of the driving wheel, with four rows of teeth also; but with the view of equalizing the wear, there is what millwrights call a hunting-cog, being one more than an aliquot part of the driver. Thus, in the present case there are thirty-seven teeth in each row, which is more than a third of the number in the large wheel. To fashion the teeth in a pinion with four rows of teeth all breaking joint, is a very nice problem indeed; and in the present case peculiar tools had to be made to meet the difficulty, so that the pinion is finished ready to gear without having a file or chisel upon one of the 148 teeth serrating its circumference. When the driving wheel weighs between 30 and 40 tons, what the engines will weigh is a natural inquiry; but we cannot answer the question at present, although we would suppose that they will be of the collective power of 800 horses, and will not, with the boilers, weigh less than probably 600 tons, a load of itself for a goodly sized ship. It is astonishing the progress that the screw propellers have made in public estimation. It is not more than six years since they can be said to have come into use, and already they are fast superseding the paddle. Indeed, the Peninsular and Oriental Steam Navigation Company have resolved upon building no more paddle steamers, being satisfied that the screw is more economical and handy in sea-going steamers.

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*Coating Iron with Copper.—Watts and Burgess' Patent.**

This patent has just been taken out for coating iron nails, sheets, and tubes, with copper or brass. As this is effected by fusion, none of the injurious consequences that take place when the coating is deposited by electrical agency can occur. A long series of trials have been conducted at Woolwich Dock Yard, in which iron bolts and deck nails coated with copper throughout their length, and having solid copper points fused to one or both ends, have been experimented upon. The copper ends are made sufficiently long to clinch. These tipped or compound bolts are quite a novelty in ship building, and possess all the advantages of solid copper bolts.

* From the London Mechanics' Magazine, August, 1853.

The experiments in Woolwich Yard, under the direction of Charles Atherton, Esq., Chief Engineer, commenced with trials to ascertain whether the coating process acted injuriously upon the iron. Bars of iron of various sizes were cut into equal lengths, and a certain number of each size were then coated. These were tested in the hydraulic machine with an equal number of the uncoated lengths; no difference in their strengths could be perceived. Other lengths were subjected to cold hammering, being bent double and beaten close, but the texture of the iron was not at all injured. Iron bolts with a solid end of copper, were then turned to exactly an inch in diameter and placed in the proving machine; in all cases the fracture took place in the solid copper, and not at the juncture of the two metals, which it was afterwards found impossible to sever with a strain equal to 21·6 tons to a square inch.

Deck nails were then driven into deal and African oak without injuring the heads, although in some instances no hole was bored to receive them. Two logs of African oak were bolted together with the pointed bolts, which were afterwards clinched in the usual way; the logs were then wedged asunder, the heads drawing through the solid wood. This experiment was repeated, a copper bolt being substituted for one of the compound bolts; when the logs were set apart the copper bolt drew through the rings, the other standing firm. The trials were pronounced highly satisfactory by the officers appointed to superintend them.

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Is this the process patented in this country by Mr. Pomeroy, of Baltimore, and reported on in 25th Vol., p. 213, of this *Journal*? The results resemble each other very much. Mr. Pomeroy's patent dates from 9th July, 1849, although issued 8th January, 1850. Ed.

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*Ingenious Mode of Ventilating Ships.**

The ship *Evangeline*, recently launched by Messrs. Jordan and Getty, has been fitted with iron masts, which are hollow cylinders, and which have been fitted with trap doors at either end, to open or shut at pleasure, for the ventilation of the ship. It has been found that a perfect ventilation can be accomplished by these masts, even when the ship is stationary, which is a desideratum in passenger ships seldom attained. The *Evangeline* has taken her departure for New Orleans, with goods and passengers, the latter being chiefly Germans. She belongs to Messrs. Clint & Co.—*Liverpool Times.*

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, September 15, 1853.

John E. Addicks, Esq., President, P. T., in the chair.
John F. Frazer, Treasurer.
Isaac B. Garrigues, Recording Secretary.

* From the London Railway and Commercial Gazette, No. 924.

The minutes of the last meeting were read and approved.

Donations to the Library were received from Edward Hinckley, Esq., Baltimore, Maryland, and Professor John F. Frazer, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer read his statement for August.

The Board of Managers and Standing Committees reported their minutes.

New candidates for membership in the Institute (11) were proposed, and the candidates (9) proposed at the last meeting were duly elected.

Dr. Rand, Chairman of the Committee on Meetings, brought before the meeting, Echols' Water Gauge for Steam Boilers. It consists of a metal cylinder of about 2½ inches diameter, attached to the boiler by two smaller tubes, provided with stop-cocks, one entering above and the other below the water line. Midway of the vertical height of the cylinder are two openings, opposite each other, in which are screwed hollow nuts, the inner openings in which nuts are closed by hemispheres of glass, the convex portion inwards; between these rises and falls a graduated rod attached to a float, the numbers on the rod being visible as they come opposite the openings.

The stop-cock at the lower end of the gauge is a three way cock, and may be thus made to cut off communication with the water in the boiler, and open a small vent tube, leading externally, by which means all the water in the gauge may be blown out in case of any obstruction. The height of the water in the gauge may also, if desired, be tested by thus blowing out the water, measuring its amount, and calculating its height, for the known capacity of the cylinder.

This invention is at present under consideration by the Committee on Science and the Arts.

Dr. Rand also exhibited a model of a Turn-Table, or Anti-Friction Box, patented by George T. Parry, of this city. In it the rollers are of the shape of double frustra of cones, reversed, and united at their bases, revolving in circular grooves of nearly corresponding form.

This invention is also, at present, under consideration by the Committee on Science and the Arts.

Dr. Rand further presented Kidders' Gas Regulator, designed to be attached between the service pipe and meter in buildings, for the purpose of preventing the fluctuations in the light, due to the unavoidable variations of pressure in the street mains. It consists of a small telescopic gas holder sealed with mercury. The upper section carries a rod, to the lower portion of which is a conical valve, apex upwards, which fits into a corresponding socket in the lower opening, or that for the entrance of the gas, which, as it rises with the upper section of the gas holder under an increase of pressure, controls the supply, and, consequently, the pressure. The apparatus resembles the governor used at the gas works to control the supply of gas from the gas holders to the street mains; the latter, however, is sealed with water.

Dr. Rand also presented Whitney's Inkstand. An ordinary glass inkstand is made entire, with the exception of two openings in its upper sur-

face. One of these is covered by an elastic diaphragm, regulated by a screw; into the other fits air tight, a small glass funnel, the neck of which reaches nearly to the bottom. By compressing the air above the level of the ink by means of the screw, the ink rises up into the cone of the funnel. The whole fits into a neat frame supporting a rack for pens, &c.

Mr. Nathan Atherton exhibited a model of a method of converting reciprocating into rotary motion, and gave the following description of it.

The nature of my invention consists in applying a cylinder with a right and left continuous groove, (forming a double inclined plane or screw,) the pitch and diameter of which is in proportion to the length of the stroke of the piston.

If for a steam engine, for example, then, according to the length of the stroke of the reciprocating motion to which it shall be applied, I construct my cylinder, called the impulse cylinder, by having cast or cut in its surface a groove, starting at a point near one end of the cylinder, and continuing around the cylinder to a point on the opposite side from the starting point, and near the other end of the cylinder from the starting point; and from this second point I continue the groove around the cylinder, returning to the starting point; thus making a continuous groove, and forming a double inclined plane.

I apply this cylinder, properly housed, so that it may revolve on its shaft. A friction wheel is attached to the cross-head, and works in the groove of the impulse cylinder. The cross-head, upon being propelled forward, causes the cylinder to make a half revolution, and upon the cross-head being returned down the groove of the other side of the cylinder to its first position, will complete the full revolution of the cylinder upon the shaft.

Mr. McRea exhibited to the meeting, his Railroad-Drawbridge, and Switch Safety Telegraph, which was described by Prof. Frazer. The object of this apparatus is, to give to the conductor of a railroad train, when approaching a drawbridge or switch, a signal by which he may know that the bridge or switch is in the right position to pass the train with safety. To accomplish this, an electric current is established from a battery, including in it, the drawbridge or switch, so that if these be in proper position, the circuit is complete at that point, but that if they be out of position, the circuit is there broken. The zinc which forms the conductor, terminates at a safe distance from the bridge or switch, in a carefully insulated rail, and the next rail, also carefully insulated, is connected with a ground plate, by which the circuit is completed. An ordinary electro-magnet is placed upon the locomotive, its armature so adjusted as to control the sounding works of an alarm; and the extremities of its coils terminating, the one on the front, the other on the hind axle of the locomotive. Then it is evident that the electric circuit is broken at the insulated rails, but that when the locomotive reaches that point, the front wheels being on one, while the hind wheels are on the other insulated rail, the circuit will be completed, and the bell sound, provided the drawbridge or switch be in proper position, but that if they should

not be so, then the bell cannot sound, for the armature will not be attracted, in consequence of the circuit being broken at the bridge or switch. It will be observed here that the indication to the conductor that he may proceed is given by an actual, audible signal, and that this signal cannot be given by any accident. The only effect of the apparatus getting out of order or not working, is to make the conductor proceed cautiously. It will also be seen that if it be found necessary in practice, the insulated rails in which the parts of the circuit terminate may be separate from the track, and placed inside or outside of it, the connexion with the engine being made by metallic springs at its front and back, projecting downwards so as to press upon them.

Mr. McRea also proposed a modification of the above apparatus to prevent collisions on single tracks. In this case, a double circuit is established from the same battery to the turn-out, at the extremities of the part of the track on which the trains may meet. The lines here terminate by circuit-changers, by which all current is stopped, while the apparatus is not in use. The conductor who first arrives at either end of this prepared track, shifts the changer, by which means he establishes the circuit from the other end through his magnet, and if everything is right, gets the signal that he may go on, leaving the changer as he placed it. Then when the other train arrives at the opposite end, he cannot complete a circuit, because his circuit must come from the other end, and has been already broken by the first conductor; he therefore knows that the other train has passed the next turn out, and must wait until it passes him. Each conductor, as he passes off the prepared track, places the circuit changer of that end in its first position, and the apparatus is ready for service again. It will be seen that these changes may be easily done, if desirable, mechanically by the engines themselves. And here, again, the derangement of the apparatus can only result in additional caution on the part of those in charge.

G. W. Smith, Esq., briefly explained to the meeting the theory of stammering, and some of the methods which had been resorted to for curing it; he introduced to the meeting Mr. Robert Bates, of Philadelphia, who formerly had labored under this disability, and had, by mechanical means of his own invention, effected a radical cure of himself, which he manifested to the satisfaction of the meeting. The method consists in the employment of a tube for the passage of air from the mouth, when the muscles that close the orifice and stop the egress of air in speaking, are suddenly contracted by spasmodic action, and the employment of a strap around the throat provided with a spring pad (regulated by a screw,) pressing against the throat, keeping the glottis or larynx open; thereby allowing a free passage through the throat and mouth from the lungs, the arrest of which causes stammering. The tube is shaped to fit the roof of the mouth, is flattened and open at each end, is about $\frac{7}{8}$ths of an inch long, $\frac{3}{8} \times \frac{1}{16}$ extending down to the teeth, where it can be fastened by passing a small wire between them; the lingual or dental sounds are thus made; the labial sounds are made by an additional extension of the tubes beyond the lips; the guttural sounds are accomplished by the pressure of the pad. By constant use of these instruments for a short time the correction of a bad habit is effected, and the tube is gradually con-